WHY WE FOUGHT

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WHY WE FOUGHT

BY

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FOREWORD BY

HON. WILLIAM HOWARD TAFT
Ex-President of the United States

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TO 73,000 AMERICANS, FRIENDS OF MINE AND OF YOURS, WHO WILLINGLY GAVE THEIR LIVES FOR A BETTER WORLD, THIS BOOK IS RESPECTFULLY DEDICATED. .·. .·. .·. .·. .·.

"To you from failing hands we throw
The Torch: be yours to hold it high!"

FOREWORD

BY HON. WILLIAM HOWARD TAFT

Ex-President of the United States

THERE is no part of our people whose opinion on the question of whether we should have a League of Nations, and whether the pending peace treaty should be ratified, ought to have more weight with the Senate of the United States than the four million of boys who were enlisted in the war to defeat Germany. They know why they offered themselves. They know what the national purpose was. They know what their fighting was intended to mean for America and the world. Still more significant is the opinion of the eight hundred thousand of those four millions who were given the place of honor in the trenches and who did the actual fighting. The most sig-

nificant of all is the view of the seventy thousand American boys who offered up their lives in the cause, and whose great purpose in making the ultimate sacrifice undoubtedly was to end all wars for the world.

The following pages are the testimony of a witness who was a soldier on the fighting front, with a keen, inquiring, intelligent mind, who speaks with authority as to what our boys intended in this war.

I first heard and met Captain Thomas G. Chamberlain, the author of what follows, on the stage of the Municipal Auditorium in San Francisco. He is a graduate of the University of California where he was a student of political science, and a fellow of his university. His training and study fitted him and induced him to make the inquiries as to the psychology of the American boy soldier, and his varied experience at the front gave him the opportunity. As soon as we heard his first address in San Francisco, we were convinced that we should have his assistance on the missionary tours of the League

to Enforce Peace in behalf of the Covenant for the League of Nations. We, therefore, invited him to become a colleague on these trips. He has been most active and effective in support of the League ever since.

Captain Chamberlain is a young man of thorough training, of high intelligence, of fine character, a sincere patriot, whose lips have been touched with the gift of eloquence.

I commend the reading of this little book of his.

WM. H. TAFT.

June 8th, 1919,
Washington, D. C.

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From the editorial page of the *Saturday Evening Post,* April 19, 1919.

SOLDIERS AND SENATORS

This letter speaks for itself and, we believe, for a majority of the men who fought the war:

March 13, 1919

Hon. William Edgar Borah,
Senate Chamber, Washington, D. C.

DEAR SIR: I attended the meeting at Boston which you recently addressed in opposition to the League of Nations. The full case was not presented at that meeting. Sailors and soldiers who attempted to speak were denied the opportunity.

A mere soldier, one among four millions, could not challenge a United States Senator; but as one so fortunate as to have been on the firing line when it was a question of the life or death of our nation, I ask permission to present at your meetings the case for the men who were willing to make and who did make the supreme sacrifice for a better world.

The American soldier fought with no selfish or sordid aim. He believed that something mightily worth while would follow his sacrifice. He believed an organization would follow which would make peace more secure. He knew little

of the details of a League of Nations; but from his everyday life he could see the necessity of organization. He now believes that it is the business of a constructive statesman to say what that organization should be, and not merely to oppose the one suggested.

We have been too busy on the other side to know what has been going on politically at home. Possibly an appeal for party support was made where it should not have been made. Possibly the Senate was not given full consideration. We do not know. But we do know that American soldiers have been dying for certain principles, and that these principles are too great to be discredited for the purpose of discrediting the man who happens to uphold them; too great to be discredited for the purpose of discrediting any party.

Of course this letter is public.

Respectfully yours,
(Signed) THOMAS G. CHAMBERLAIN,
CAPTAIN, U. S. ARMY.

Address:
Hotel McAlpin, New York City.

Note: This letter was also printed in the *Independent* and in many leading newspapers, including the New York *Times*, New York *World*, Springfield *Republican*, and Boston *Globe*. Expressions of hearty approval have come to the writer from all parts of the country.

WILL THE SENATE LOSE WHAT THE SOLDIER WON?

Peace follows justice.
Justice follows law.
Law follows political organization.

MACHINERY OF THE LEAGUE

THE representatives of the United States at the Peace Conference, together with the representatives of thirty-one other powers, have unanimously recommended a Covenant for a League of Nations establishing a democratic international organization for the purpose of coöperation and the prevention of war. The Covenant has already received the criticism of the United States, and based on this criticism amendments have been made expressly safeguarding the Monroe Doctrine, removing immigration and domestic questions from the jurisdiction of the League, requiring a unanimous vote in matters of vital interest and providing for withdrawal.

It is believed that the Covenant in its present form embodies the great principles for which the war was fought and that it

will establish a rule of right in the world. In view of the importance of the subject and the impending action by the United States Senate, it is sincerely hoped that the American people will insist on a fair and impartial consideration, unaffected by personal or political motives.

The League is not a world-state or a super-sovereign. The obligations assumed are contractual, and for the fulfilment of these certain machinery is provided. First, an Assembly, in which all States members of the League are to have three representatives, and one vote. Secondly, a Council of nine members, on which five States,— the United States, Great Britain, France, Italy and Japan,— are always to be represented, the four other States to be named by the Assembly. (Pending the naming of these States, the Peace Conference has agreed that Belgium, Brazil, Greece and Spain will be the States represented on the Council.) Thirdly, a Secretariat, made up of a general secretary to be appointed by the Council, subject to ratification by the As-

sembly, and his assistants, to be appointed by him, subject to ratification by the Council.

The States victorious in the war are to be charter members, together with such other States as may be invited and shall accept the invitation to join. It is not proposed to make the Central Powers members of the League at once. There will be time enough for their admission, as Mr. Taft so aptly says, when they bring forth fruit meet for repentance. But, eventually, of course, if the old balance of power is to be prevented, all States must become members. The advantages of membership are such that States will wish to join, and admission may be had by a two-thirds vote of the Assembly. A State may withdraw on two years' notice, provided its international obligations are fulfilled at the time of withdrawal.

The Council is to submit plans for a court of international justice for consideration and adoption by the Council. In addition, there will be a Commission

on Armament and a Commission on Colonies. It is agreed that international bureaus and commissions hereafter constituted shall be placed under the League, and such as are already established by general treaties shall come under the League if the parties to such treaties consent.

PEACEFUL SETTLEMENT OF INTERNATIONAL DISPUTES

THE fundamental covenant made by members of the League is to permit delay for arbitration or inquiry prior to the outbreak of hostilities. To understand how this delay is to be introduced in every case is to understand the heart and crux of the Covenant.

The importance of such delay is illustrated by the experience of the Irishman who found that the resolution to count ten before striking the first blow kept him out of trouble. Possibly it can't be said that the ordinary Irishman would keep this resolution, but if he kept the resolution he would keep out of trouble. The practice between nations at present, as between certain select individuals of pugilistic lore, is to strike the blow and count ten afterward. It doesn't take an

expert in the psychology of violence or a veteran of the great war to point out the importance of delay. Those who have had only domestic encounters know how important it is — in preventing the outbreak of hostilities.

And delay has the same pacific tendency in international relations that it has in personal relations. In 1905 a serious situation arose in Morocco from the Kaiser's declaration of policy. A battleship landed off the coast of Agidir and war seemed imminent. Through the influence of Mr. Roosevelt, who was then President of the United States, the Algeciras Conference was called. The machinery was set up after the dispute had arisen, after tempers had become quickened, after peoples had become angered, after statesmen had become embittered; afterward and not before, as would be the case under the League. As a result of the Algeciras Conference, delay was introduced; the whole subject was discussed; public opinion was focussed upon the issues; French claims were established

in Morocco; the Kaiser had to back down, and war was averted.

Again, in 1912, a serious situation in the Balkans led the great nations to the brink of war. Once more, fortunately, they were successful in setting up machinery. The Conference of London was called. Discussion was had. The force of public opinion was felt and war was prevented.

We now recall those dark days during the latter part of July, 1914, and remember the cry that went up from every foreign minister of Europe; the cry that went up from the people of the entire civilized world. They were asking for delay, for conference, for discussion. But the Kaiser answered, "There can be no delay!" And why no delay? Because he knew, as we must know, that delay is fatal to the cause of the aggressor.

If the Covenant of Paris contained one provision, and one provision alone, and that a provision introducing the element of delay prior to the outbreak of hostilities, it would represent a great step in

advance; it would be worthy of acceptance by the American people; worthy of adoption by the United States Senate.

When the ordinary processes of diplomacy fail to-day, the next step is war. Under the League of Nations, the next step after diplomacy fails will be arbitration or inquiry. The machinery will be in existence by which such arbitration or inquiry can be had. Under the covenants of the League the necessary delay will be enforced.

It should be understood just how this element of delay is going to be introduced in every case after diplomacy fails. The nations agree, when a dispute arises, to go either to arbitration or to inquiry. If they agree to arbitration, they agree to abide by the finding of the arbitrators. There can be no hostility during a reasonable time allowed for arbitration, and not until three months after the finding, and not even then as against a nation that fulfils the award. The reasonable time allowed for arbitration, plus the three months, gives time for conference and dis-

cussion and the operation of public opinion.

If the nations do not agree to arbitration, the case goes to inquiry, ordinarily before the Council. In order that the report here given should be effective, it is necessary that it should be unanimously agreed to by all members of the Council, parties to the dispute of course excepted. There can be no hostility during six months allowed for the report and not until three months thereafter, and not even then as against a nation that complies with the report. Of course if the required unanimity is not had in the Council, the parties are free to take such action as may be necessary for the protection of their rights, but whether the required unanimity is had or not, there has been a delay of many months during which the forces of public opinion can operate.

The Council may transfer the inquiry to the Assembly, and it may be so transferred by either party to the dispute merely by giving notice within fourteen days after the dispute has been filed. For

the report of the Assembly to be effective, it is necessary that such report should be unanimously agreed to by all States, members of the Council, and a majority of all the others, except, of course, that a party to the dispute cannot act as judge in its own case. There is no more assurance that agreement can be reached in the Assembly than in the Council, but, in any event, the important element of delay is introduced and by delay many wars can be prevented.

ENFORCEMENT OF COVENANTS

THE members of the League are nations that regard treaties of peace not as scraps of paper but as solemn obligations. If, however, any nation should undertake hostility in violation of the Covenant to allow arbitration or inquiry first, then such nation is to be immedidiately boycotted by all the others. This means that all relations — financial, commercial, personal — are to be severed with the offending nation. This represents a very grave penalty indeed.

There was a time when nations could stand alone and by themselves, but today, with the progress of civilization, the development of mechanical methods, and especially the improvement in means of transportation, no nation can provide for its citizens a satisfactory state of welfare without the most extensive international

relations. These international relations are not theories, they are facts. The disputes arising out of them are not theories, they are facts. The machinery for dealing with these disputes when they arise, and for settling them more economically and more justly than they could be settled through war, is to-day a theory, and it remains for enlightened American opinion to translate this theory into a fact.

Through the arteries of trade the life of nations is linked up. The vitality of nations is such a common thing that no nation can enjoy a state of peace while other great nations are at war. How well do we know this from our experience prior to our entry into the Great War. To-day no nation can claim neutrality as a right any more than the citizen at common law could claim to stand aside as a right while the criminal was being pursued. The peace of the world is the business of the world, and in that business the United States must share her part of the responsibility.

It is now admitted that had Germany at one time made her blockade against England effective for two weeks, she could have starved out that country. This international dependence is a fact.

When we are told that the United States is going to be drawn into small wars all over the face of the earth, the simple answer is that the blockade is certainly going to prove effective in the case of the small nation, if not in the case of the great and powerful, like the United States.

If, however, the blockade should not prove effective, then the Council is to recommend what military force is to be supplied by each of the several powers. It is not contemplated that the benefit of this League will come in ordinary course through the use of this military power. This is not a league for war; it is a league for peace. The organization of the military power of the world will be sufficient as a potential force to secure the enforcement of the covenants. What nation would care to undertake the hos-

tility of this organized body? — to such an issue there could be but one outcome.

The Monroe Doctrine has never cost us a single shot nor has it cost us the life of a single soldier, and yet that guiding, all-powerful, parental hand of the United States, watching the destinies of the peoples of South America, has been sufficient to prevent aggression, to guarantee the territorial integrity and political independence of those peoples, not through its use, but through the threat and warning of potential force.

ARMAMENT

THE evils of competitive armament are well known. If, in addition to the great burden brought upon the people of the belligerent countries by this war, we are to add the burden of greater and greater armies and navies, the outlook is certainly not encouraging.

In India, a country having great need for education, even before this war there was spent each year twenty times as much on armament as on education. This same lack of educational facilities, while great sums are being spent on armament, is true in all countries of the world to a greater or a smaller extent.

We must do something to relieve this great burden. Under the League it is provided, not that the regulation of our army and navy is to be turned over to foreign powers, as our opponents tell us,

but that the Council is to recommend a general reduction of armament for each of the several powers. The recommendation must be unanimous, which means that the representative of the United States must vote for it, and in the second place the Council can only make a recommendation, and final action is reserved to our own Congress. Does this seem like leaving the determination of our armament to foreign powers?

The peoples of the world are burdened with competitive armament, and under the League we are going to lighten that burden. It is easy enough to condemn and to say that the League is all wrong, but what do the opponents of the League propose for the reduction of armament?

SECRET TREATIES

As President Wilson said in the Metropolitan Opera House in New York City, "If the League of Nations were nothing but a great debating society, it would kill intrigue." These secret, underhanded treaties, by which whole nations are plunged into war without even knowing the reason for it, must be eliminated. The League of Nations sounds the death knell of secret treaties and secret diplomacy.

From the very fact that we have had in Paris a meeting together of the representatives of the several powers, several secret treaties have been brought to light. We are now discussing treaties that we did not know anything about a few months ago. These treaties are outlawed under the League. No treaty is to be binding until it is filed with the general secretary and made public.

A treaty is a contract, and the essence of any contract is the consideration, the obligation. Should such treaties be made in violation of the Covenant, it would only be necessary to appeal to the League for relief from the fulfilment of the obligation. Ask the opponent of the League of Nations how he proposes to eliminate secret treaties without some such coöperation among the nations as is here proposed.

THE COLONIES

WHAT are we going to do with the German colonies? This was a question that the Peace Conference had to answer. Germany had maltreated the peoples of those colonies; she had abused them. We could not return the colonies to Germany. What would the opponents of the League have done with them? Would they have turned them loose, as the prey of any power that might care to grab them?

Under the League, this fundamental principle was laid down, and even the opponents of the League must admit that this principle is sound: backward peoples constitute a sacred trust of civilization.

We did not stop with the declaration of this principle but provided the machinery by which it could be carried out. The Powers best suited to undertake the mandate for backward peoples were appointed

by the League, and every year the Powers so undertaking these mandates must report to the League upon the execution of the trust,— sacred trust that we have declared it to be.

This constitutes an effective settlement of the colonial problem, and there has been no other effective settlement proposed.

"Ye shall know the truth and the truth shall make you free"

"Where there is no vision, the people perish"

Speech Delivered By
Captain Thomas G. Chamberlain

Before the Pacific Coast Congress for a League of Nations, San Francisco, California, February 19, 1919.

Mr. President, Ladies and Gentlemen: The invitation to speak here this evening with such distinguished persons came as a surprise to me, and it was with apprehension that I accepted. But I am glad of the opportunity, glad because I feel that I have something to say to you, something that the soldiers would wish me to say to you; the soldiers, not only those who have served here at home, not only those of us who are just returning from overseas, not only those who are yet to be returned, but also those who shall never return.

I have talked with the soldiers in the camps in this country, on the high seas, in the hospitals of France, and in the trenches. I know what the soldier felt. Many of our conversations I might tell you of, but I shall refer to only one; only one, because it is typical of them all. It was a gloomy night on the western front behind the lines at Chateau Thierry. I was talking with a soldier — a doughboy. The military situation was critical, and we knew it. The Italians had met with serious reverses. The French, after a stubborn fight, had lost Chemin-des-Dames, perhaps the strongest position on our line. The Germans had attacked in Flanders, where the British and Portuguese armies came together, and had opened a gap. The British Fifth Army had been turned back into Picardy. The situation was critical. As we talked we could hear the roar of the artillery far up and far down the line, and before us the star shells lighted the sky. He told me of his experiences in going over the top; he told me of his exploits in No Man's Land.

He told me that he was going over again in the morning and, when he left, he said — and I shall never forget his words, "We have a big job to do, but we are going to finish it and finish it forever, and," he added, "if I can help finish it, I won't mind one of those wooden crosses for a monument, like those other fellows have."

He went over in the morning. He didn't come back. He has a wooden cross for a monument. And those of us who are here to tell the story, no matter what our future acts may be, shall never have a monument quite so high or quite so glorious as his. "He lives in fame who dies in virtue's cause."

It was no sordid aim that took that man over the top with the fields and roads plowed by shell fire, with the trees shattered and splintered and torn, with buildings razed to the ground; it was no sordid aim that turned the tide at Chateau Thierry. It was no sordid aim that wiped out that gas-soaked, shell-shocked salient at St. Mihiel. It was no sordid

aim that waded through the fiery, burning hell in the Argonne Forest.

Was this a war for democracy? Was it a war to end war? Was it a war for a new era, a new order, a new international order, which should ensure the enforcement of right and justice between nations?

These are questions to which the soldier desires an answer. There are a few who say it is all bunk and, unfortunately for us, some of these few are now sitting in the United States Senate. But the fact is that the soldier believed it was not bunk, and, so believing, he marched willingly to fight and often but not less willingly to death.

I testify that the American soldier gave his life not merely to win a war but to win a cause. That cause involves benefits and it involves responsibilities. Are we going to assume those responsibilities or are we going to dodge them?

When John Hay sent an international expedition into China, he was not trying to dodge the responsibility of the United States. When that great student of John

Hay's, and that great American, Theodore Roosevelt, sent Mr. Henry White, one of our representatives now in Paris, to the Algeciras Convention, he was not trying to dodge the responsibility of the United States. On that occasion the Kaiser sent three telegrams to Mr. Roosevelt attempting to bring about a change in his attitude, but Roosevelt stood his ground, with the result that French claims were established in Morocco and the Kaiser had to back down. Finally, my friends, though Senators may dodge, when the mothers and fathers of America sent us across the water, they were not trying to dodge the responsibility of the United States.

We can now establish a reign of law based on the consent of the governed and sustained by the organized opinion of mankind, or we can return to secret treaties and competitive armaments. The choice is yours. The new order, under the leadership of President Wilson and Mr. Taft, with all that it means to mankind: the old order, with the verdict of

history that these dead have died in vain; the old order, a sorry harvest to reap from the blood of seventy thousand American crusaders that has soaked the fields of France.

Speech Delivered By
Captain Thomas G. Chamberlain

Before the Mountain Congress for a League of Nations, Salt Lake City, Utah, February 22, 1919.

Mr. President, Ladies and Gentlemen: The last year I spent on the front in France, I was concerned with one problem and one problem alone, that,— the winning of the war. But I have had an insight into the thought and purpose of the man who has borne the brunt of the fighting and to-day I wish to tell you of that thought and that purpose, and something of the circumstances under which they were determined.

The man who tells you that the soldier does not think, does not know him. Of course, there is no time in the army for

drafting constitutions for a League of Nations. With the details, the soldier is little concerned, but he knows how necessary organization is. He knows that he can't get the " slum " into his messkit without standing in line. He fought with zeal and determination to defeat Germany, spurred on by the belief that with a defeated Germany, an effective world organization would follow, an organization that would put an end to war.

So many and so varied have been the circumstances under which this belief has been expressed to me that I hardly know which to tell you of.

But turn with me to those dark days last Spring, those days after Italy's forced retreat, after the loss of Chemin-des-Dames, after the split between the Portuguese and British armies, after the sad experiences of the Fifth Army, after the drive before Soissons and Rheims, the drive that forced the salient through to Chateau Thierry. Recall those days when the Germans came on and on and ever on. It seemed that nothing would

stop the advancing hordes. Artillery had been massed and all was in readiness for the final drive on Paris, which was to end the war.

Then came the Marines, and there on the 6th day of June a glorious page in American history was written. As the Greeks of old, who "Gathered the barbarian sheaths into their breasts and, by perishing, saved the world," so the Marines drowned the German monster in a welter of American blood. Eight thousand Marines went into the fight, eighteen hundred came out of the fight. In all the history of land warfare there has never been a body of troops which, for courage, morale and determination, could excel the United States Marines. They turned the tide. They saved Paris. They saved France. They saved the war. They saved the world.

You have heard much in praise of the Marines, and they are worthy of it all. Then, too, the Aviators played a great part in the victory. Many Esquadrilles had replacements running over one hun-

dred per cent. every few days. You recall what that great leader, Lloyd George, said of the aviators: "They are the knighthood of the war. They are the cavalry of the clouds. Every flight is a romance; every report is an epic." All credit to the Aviators.

But there is another branch, not so much heralded, yet worthy of much credit. I refer to the Infantryman, the "doughboy." He carries a bayonet. He goes over the top. He meets cold steel with cold steel. He fights. I saw one company of infantrymen go into the lines at Chateau Thierry with two hundred and fifty men. That company came out of the lines with twenty-nine men.

Here it was that I talked with the soldiers, talked with them under circumstances that would certainly guarantee the truth and the sincerity of their opinions. I talked with them just before their deaths. I know that the soldier did not believe that this was merely a war among wars. He believed this to be an epoch-making war and that something mightily

worth while would follow his sacrifice.

The battlefield was thousands of miles from the United States, and possibly some judged war by good-looking uniforms and a brass band. What Senator has seen the torn and mangled bodies of fallen men, men hanging on the wire for hours with one hope and one prayer and that for a friendly shot to end the agony. I have seen men's eyes eaten out by gas. I have stood by, unable to help, as the gas ate slowly into their lungs, and have seen them gasp for the last and final breath. That is war.

And the worst is not found in the physical suffering of the men, but on the trail of the refugee. There are those who give more than life itself — the lives of those dear to them. I have seen an entire family trudging along the road homeless, helpless, hopeless, perhaps driving a goat as their sole possession, but more often without possession. Once I saw a mother carrying a new-born child. The mother looked pale and haggard, but the child no longer suffered.

And as they filed along the roads, they would sometimes stop and with a stone, against the wall of a ruined house, write the names of those they had loved and lost. I remember the bent and tired form of an old French peasant who asked a light at dusk, and, as the tears streamed down his face, he wrote his name and that of his beloved wife. Over and over again he wrote the names of a couple parted, perhaps forever; and, as he wrote, he dropped the stone, turned, went sobbing out into the darkness which led, he knew not where.

I returned to this country on a ship with two thousand wounded men. There were legs gone, arms gone, eyes gone. Sometimes so much gone that it seemed 'twere better if all were gone. On the boat there was a cage for shell-shocked men — men driven insane. I liked to talk with the wounded men because among them I found a spirit unequaled. One young fellow, leaning on crutches and supporting one crutch by a stump of an arm while nursing a bad head-wound, said he

would have preferred a grave in France, but added, " At last the world has learned the lesson that wars must end."

It was from such scenes of hopefulness as this that I went to the United States Senate, and there, to my utter dismay, I found that the very principles were being condemned for which American soldiers have been giving their lives.

It may seem presumptuous for a mere soldier, one among four millions, to take issue with one so high and dignified as a United States Senator. I claim no more credit for myself than is due to the lowest " buck " private who carried a rifle in the rear rank; but that lowest private can stand squarely on his two feet, look full in the face the most distinguished descendant of Rip Van Winkle who ever sat in the United States Senate, the greatest man who ever represented or misrepresented th American people in that body, and say, " When it was a matter of the honor and integrity of our country; yes, when it was a matter of the life or death of our nation, I was on the firing line."

The plain soldier has earned a right to be heard. He asks that American opinion hear him and then he says: "We have had enough of war, we have accomplished our end in the army by organization. We believe in organization Internationally, we are unorganized. Internationally, we are in a state of anarchy. We don't believe in anarchy. We believe in order through organization."

The soldier fought to make the world safe for democracy and he is going to fight to keep it safe. The American people accepted President Wilson's statement of our war aims, and supported the war with the conviction that the defeat of Germany would mean the birth of a new freedom. All of the belligerent countries and the great mass of mankind the world over accepted the Fourteen Points, one of which provided for a League of Nations, as the basis for the armistice, and as the only basis for a just and lasting peace. The fact that the soldier fought and bled and died for a

better order, that the American people poured out their money in the faith that a new era approached, that all the belligerent governments accepted the principle of a League of Nations, that the mass of mankind, the world over, has hoped and prayed for the end of war, did not prevent Senator Borah from saying on the floor of the United States Senate, without even a suggestion for better organization, "If the Savior of mankind should revisit the earth and declare for a league of nations, I would be opposed to it." Is this the representative of the American people or are they more truly represented by the men who made the supreme sacrifice for a better world?

Twenty-four hundred years ago Greece at Platæa defeated her Persian invaders and drove them finally and forever from her lands. To her dead soldiers she erected a monument. For that monument her poet, Simonides, wrote the Epitaph. In that epitaph he made the dead heroes speak and this is what they said: "If to die nobly is the chief part

of excellence, then to us of all men Fortune gave this lot; for, by hastening to set a crown of freedom on Hellas, we lie possessed of praise that grows not old." By so much as the freedom of the world to-day is of greater moment than was the freedom of Greece of old, by that larger measure do our dead heroes lie possessed of praise that can never grow old.

I speak and feel as I do, not primarily because I admire President Wilson as a great leader in a great cause, not primarily because I admire Mr. Taft as a man big enough to put principle above partisanship, not because of any debt I owe to any living man, but because of a debt I owe, and because of a debt you owe, to almost 100,000 of America's best citizens, who now lie sleeping in lonely graves in the far-off fields of France. To-day a voice comes to me and to you from that distant land. It speaks with one accord and asks, "Have we died in vain? Oh, have we died in vain!"

Speech Delivered By
Captain Thomas G. Chamberlain

Before the Mid-Continent Congress for a League of Nations, St. Louis, Missouri, February 28, 1919.

One year ago I was in the city of Paris when forty German Gothas, painted black and flying at 120 miles an hour, came over the city and dropped their bombs. Great buildings were destroyed; men, women and children were killed. There were only forty planes. Why should there not be four thousand? If we go on under a system of competitive armaments, there will be, and the city will be destroyed in a single night, before there has been a declaration of war; and there is no city on the face of the earth that need not await the same fate. Considering the present development of the hydroplane

and the number of such planes that can be transported on a single ship, no city could feel secure.

I was in Paris when " Big Bertha," the German long-range gun, opened fire on the city. At regular 15-minute intervals the bursts occurred and each burst spelled destruction and death. There were only two guns — why should there not be 200 with bursts occurring at intervals of a few seconds or continuously? I have seen a tank come up out of a shell hole, the sides of which were so steep that a man could not climb up. Tanks as large as locomotives — why not movable forts with heavy guns?

Recently an American flew over the city of London in a Handley-Page with forty passengers. Within the last few months we have come to classify bombs by tons rather than by pounds, as previously. We know that an American scientist discovered a gas so deadly that a few bombs containing it would have destroyed every vestige of life in Berlin. Both sides so feared the resultant horrors that they

hesitated at dropping gas bombs on cities. To consider the possibility of the developed engines of war — the developed aëroplane, tank, long-range gun, gas bomb, gas shell, submarine, under the system of competitive armaments — is to arrive at the inevitable conclusion that civilization must, here and now, end the war or be ended by it.

Competitive armaments not only cause war and therefore constitute a challenge to civilization itself, but they undermine the very foundation of free government. President Lowell, distinguished authority on political institutions that he is, will tell you that English political history represents a struggle for the establishment of the principle that the House of Commons is supreme, that the House of Commons shall determine questions of policy and determine the amount of taxation. In 1913 the first Lord of the Admiralty appeared in the House and said, "Germany has undertaken an increase in her naval program. When Germany lays two keels, we must lay three." Accordingly, the

proposed increase in the Navy was undertaken and the necessary taxes were voted.

In France, where representative government was only established by a bloody revolution, the length of compulsory military service was determined by the whim of the Kaiser. An increase in the German army meant an increase in the French army. Our own military and naval policy will be determined by the action of other nations. The peoples of the world can eliminate a policy dictated by fear and suspicion and gain true representation only through the meeting of their representatives for common action, as proposed by the League of Nations. Final consent is, of course, reserved to our own Congress.

We went into this war for the very good and sufficient reason that we could not keep out with honor. There are some people, apparently, who do not yet realize that when Germany attacked France and Belgium she was attacking the United States. Freedom was at stake. Our ships were sunk on the high seas; our

citizens were ruthlessly murdered on merchant vessels where they had a right, under international law, to be. When free institutions are challenged the United States stands ready to oppose and we will not ask that others fight our battles. We are not ashamed of our record in this war. We are now ready to stand with all free peoples for the freedom of the world, just as we have stood during the last year.

The policy of glorious isolation didn't keep us out of this war, and it won't keep us out of any great war. Mechanical methods and modern transportation have made the world smaller. To-day, the peace of the world is the business of the world and in that business the United States must take full share of the benefits and the burdens. That is only fair play.

George Washington was a man who looked squarely at the facts and then looked forward. George Washington was the man who presided at the Constitutional Convention that gave us the Constitution of the United States. Was he looking backward? At the time of his

farewell address, he certainly had no such world organization, as is here proposed, in mind. The very purpose of this organization is to prevent the alliances he objected to. I firmly believe that if George Washington were alive to-day he would favor the League of Nations.

Even if it were admitted that Washington, in his day, opposed such organization, nothing is established thereby. Washington said that a stage-coach was the best means of transportation and in his day he was entirely right. Great disciples of Washington that certain Senators have recently become, they don't use the stage-coach.

From one year in France I learned the true feeling of the American soldier. While he had no elaborate means of expression and no elegant ideas on the details of a League of Nations, he believed that something mightily worth while would follow his sacrifice — that he warred to end war and that our of his efforts would come an effective international organization which could render the

recurrence of such a catastrophe improbable if not impossible.

I recall those dark days last Spring after the defeat of Italy, the loss of Chemin-des-Dames by the French, the defeat of the Portuguese in Flanders and the breakdown of the British Fifth Army in Picardy. It seemed that nothing could stop the German armies and, as they drew closer and closer toward Paris, the question was asked with greater and greater anxiety, "Who can stop the onslaught?" How proud I was as an American in those dark days, to see the American standard raised high at Chateau Thierry and carried victoriously onward through St. Mihiel and the Argonne Forest toward the River Rhine. In this critical period of the world's history, when the peoples of the earth cry out for leadership, is the United States going to stand up to the standard of leadership erected by her soldiers? That is the issue!

It was a great surprise to me upon returning to this country to find that the very principles for which the American

soldier has been dying on the battlefields of France were being condemned on the floor of the United States Senate; and what is the argument he hears? He is told that in 1848 the United States had trouble with Mexico — that we got what we wanted, and he is asked if such a case should recur would we wish to leave it to foreigners.

If this war has established any principle it has established the principle that there is a moral law above the state and to that moral law the state must answer. It was the Kaiser who believed that the state was all supreme and irresponsible.

The trouble with certain Senators is that they are steeped in the philosophy of Kaiser Wilhelm, the philosophy we fought to kill, the philosophy that died with the defeat of Germany.

And who are these fearful foreigners? It now happens that there are about two million "Yanks" who, by close association, by living in the same dugouts with "Poilus" and "Tommies," have learned a new lesson. We have discovered that

the Britisher, Frenchman, and Italian are two-legged animals, about like ourselves, who eat, sleep, fight; yes, and even think as we do, and we have about made up our minds that we can better put our trust in these fearful foreigners than in certain men who claim to represent us in the United States Senate.

Throughout the great war the world has turned to America for moral leadership. It now rests with the power of a United American opinion to lead the world ~~to the victory~~ of Peace by the establishment of an effective League of Nations.

Speech Delivered By
Captain Thomas G. Chamberlain

Before the Southern Congress for a League of Nations, Atlanta, Georgia, February 26, 1919.

The fight for a League of Nations will go on, but so far as this trip is concerned we are approaching the end of the trail. Those of you who attended the World's Fair in 1915 at San Francisco remember the statue of the duck baby, and those lines —

"Thus ever it is in this world of ours,
The brightest light must fail,
There is a tear in the eye and an aching heart,
When we come to the end of the trail."

So it is that I feel about this trip.

Great changes are wrought by war. A few months ago I was riding in a box car

in France, a car with holes in it large enough to throw a cat through while the temperature was several degrees below zero. The car bore that label which has become a slogan with the American Expeditionary Forces, "40 L'homme, 8 cheveaux." I translate it, not because I doubt that there are those who do not speak the language of our glorious ally, but because I have reason to doubt my own pronunciation. As one of the men in my battery said when writing home to his mother, "I studied French for two years before I came over here and speak it perfectly, but these people don't know their own language." 40 L'homme, 8 cheveaux,— 40 men, 8 horses, and the only difference was that the horses had straw to sleep on. My bunkie on that box car was an Italian, who spoke no English. I know that he spoke no English; I also know that I speak no Italian because several weeks later he came to me and said something that sounded like the Latin I once learned and forgot. I thought he wanted to visit one of the towns in the

rear and, desiring to give him the same privileges that the other men had, I said, yes. He left, and didn't return; and later I learned that he had gone to Italy — so far as I know, with my permission. Such are the changes wrought by war that in the course of a few short months I have graduated from that humble box car in France, with my humble bunkie, to the special car of the ex-President of the United States, and my bunkie is none other than the distinguished scholar and learned head of one of our greatest universities, Dr. Lowell.

I wish to have a personal talk with you. I wish to talk about myself. I haven't ventured to do this before because I desired to finish the trip, but now we have arrived at the end of the trail. I graduated from the University of California in 1915 and returned to the University for two years' graduate work in the legal department, during which time I held a teaching fellowship in Government. I had occasion to follow very closely the events prior to the entry of the United

States into the war and to consider the purpose of the war. Soon after our government came in I enlisted in the army and there I made it my business to find out what the men thought. In the camps of this country, on the high seas, in the hospitals of France and in the trenches I have talked with the soldiers. The soldier believed that this actually was a war for democracy; he did not consider this a war among wars; he considered this an epoch-making war. He believed that something mightily worth while would follow his sacrifice.

"I sometimes wonder if the situation last Spring looked as serious to you on this side as it did to us over there. We knew of Italy's misfortune, we knew the importance of Chemin-des-Dames, and that the French, after a fight against great odds, had lost it. We knew of the retreat of the Portuguese in Flanders and of the British 5th Army in Picardy. We knew that the German hordes were coming on and on. As we went out from Paris to Chateau Thierry last Spring, we could see

the appearance of despair on every hand. French peasants had piled high their two-wheeled carts with household goods and were leaving for other parts. The question was asked on every hand — who can stop the German advance? Troops returning from the line looked worn and weary and did not seem to entertain much hope for the situation. I remember the night at dusk when it seemed that all was lost, there came swinging up the road a long column of troops and they were singing, " The Yanks are coming, the Yanks are coming." And the Yanks were coming.

As they marched along the road a French liaison officer, pale and excited, approached Colonel Wise, saluted, and said hurriedly, " Sir, your orders are to hold the advance as long as possible and then retreat to the trenches; we will prepare for you in the rear."

" Retreat," said Colonel Wise. " Retreat Hell; we are just coming, we will let the Germans retreat,"— and the Germans retreated.

In one determined smash the whole course of the world's history was changed. When it seemed that all was lost I was proud at Chateau Thierry as an American to see the American standard raised and carried victoriously forward. It took that same standard to wipe out the salient at St. Mihiel. It was that same standard that waded through hell in the Argonne Forest, and went victoriously on to the river Rhine, on to the victorious end of the greatest war of all time.

At this critical period in the World's history, when the peoples of the world cry out for leadership, is American opinion going to rally round the standard which American soldiers raised on foreign battlefields? There are those who ask retreat, but the American soldier answers just as Colonel Wise answered at Chateau Thierry.

A few weeks ago I visited the United States Senate and was utterly dismayed to find that the principles for which American soldiers have been dying in France were being condemned on the floor

of the Senate. It makes my blood boil to think that our distinguished representatives do not display the same willingness to play the game that was displayed by our men over there.

Well may it be said that if Mr. Taft were a modern Catiline condemned by Cicero for conspiracy, and if President Wilson were an Aaron Burr of to-day, their condemnation on the floor of the Senate could not be more bitter. Yet of what crime are they guilty? In all sincerity and in all earnestness they have attempted to do the will of God and fulfil that prayer of the Savior, for " Peace on Earth, Good Will Toward Men."

As this is my Swan Song I wish to read you a bit of verse which I have never read to an audience before, and may never again. It was written by a man in my Battery, a " buck " private; not even a first-class private. He wrote this in a letter to his mother, and while censoring the letter I found it. That it represents the thought and purpose of the soldier is borne out by the fact that practically every

man in the Battery made a copy and sent it home, if he knew how to write and if he had a home.

Why is this strife and turmoil
Loose in the world to-day?
Why are the armies gathered?
Why is this warlike display?
Each night the flare of the cannon
Paints the northern skies all red,
Each eve are hundreds of missing —
Missing — wounded or dead.

Farmers are gone from the harvest,
Husbands are gone from their wives,
The earth is plunged in sorrow
Mourning a million lives,
Children cry for their fathers
And women grieve for their men,
Mothers, half doubting, are praying
Their sons shall return again.

Towns and cities are ruined,
Thousands of fields lie bare,
War holds earth in her clutches,
The sea and the land and the air.
What can the old war offer
As a recompense for this?
Can the things we shall gain ever banish
The forms and the faces we miss?
What of the wife, now a widow?

And the mother whose sons are gone?
Will peace bring back our missing
And happiness go on?

Cheer up, O grieving mothers
And all of you who mourn,
Our dead are dead victorious
For the larger world unborn.
To them fell the task of the ages
And, oh, how gloriously
Have they fought and died and suffered
To free Humanity.

Free from the bands and the shackles
That bound us to the past;
Free from the strife and struggle
And to make this war the last.
Free, and each man in kindred
To a hundred million others,
And earth again an Eden
Where men may dwell as brothers.

Speech Delivered By Captain Thomas G. Chamberlain

Before the State Convention for a League of Nations, Portland, Maine, May 23, 1919.

"THERE comes a tide in the affairs of men which, taken at the flood, leads on to fortune." Judging from the arguments against the League by certain Senators they would class these lines as a very low form of literature because they were written by an Englishman. But most of us require a little more proof than that to establish their worthlessness, and most of the United States will judge the Covenant of Paris on its merit. A great tide in the affairs of the world has come. We must take it at the flood and go on to fortune; or reject it and before the tears and blood of this war are dry, prepare for

another world catastrophe under which our civilization cannot endure.

We stand at the threshold of a new and better world order. There is danger that we shall not enter, but there is more imminent danger that by amendment we shall ruin the very foundation of the structure in which our high hopes are housed.

We come before you advocating the League of Nations as it is. We ask only that you read the Covenant, come to a decision, and do all in your power to make your decision the decision of your government.

The people of the country who very properly turn to their Senators for enlightenment hear from Senator Reed that the Covenant is a cruel and monstrous document by which the United States would be enslaved to black and yellow races. That statement is untrue and the proof that it is untrue is to be found in the Covenant itself. I ask you in all solemnity: Is a stricken humanity standing amidst the blood and ashes of the cruelest war of all history to be defeated as it gropes toward

peaceful settlement of international difficulties by bald and unvarnished misstatements of fact?

That statement of Senator Reed's must be denounced as a malign attempt to defeat by the politician's tongue what has been won by the soldier's blood.

Will the ratification of the League mark the day of America's surrender to foreign powers? The foundation principles, the corner stones of the League, are disarmament and arbitration, and these are American principles. More international disputes have been peacefully settled since the founding of our Republic than were settled in all human history, prior to that time. In 1790 Congress provided that our army should consist of "twelve hundred souls." Before the Civil War there were fifteen thousand men in the Federal Army. Before this war we had an army of one hundred thousand men as against the millions in the European armies. The ratification of the Covenant by the Senate will not mark the day of America's surrender to foreign powers; rather will

it mark the day of America's triumph, for on that day will great American principles be spread to all the world.

There is talk of a treaty of peace first, and a League of Nations afterward. I hope that peace comes quickly; I hope that the treaty may soon be in force; but as one who has seen the results of a violated treaty, who has seen the rape of Belgium, the death and destruction that followed in the wake of that decision to regard a solemn treaty obligation as a scrap of paper, I hope that peace never comes, I hope that the treaty never goes into force, until as part and parcel of that treaty there is an organization to stand behind it, to guarantee its terms and to enforce those terms.

Suppose we provide in the Treaty, as we should and as we have, that Poland is to be an independent state. Suppose that Germany signs the Treaty. Suppose that in a few months or in a few years Germany decides to annex Poland. Now, consider the chaos of Russia, the condition of England — in fact, of the British

Empire — after the drains made by this war. Consider the condition of the industries of France, of those towns along the French border as I have seen them and as you know them to be, and tell me what power is there to step in at once and stop that aggression should it be undertaken. There is no power and there will be none unless it be the League of Nations.

Did we set up before the world that the rights of small peoples are just as sacred as the rights of great and powerful and declare that the fulfilment of that principle was one of our war aims only to back out, only to back down, now at this the hour of greatest hope of these peoples, when it seems that after years of oppression they are about to realize these national hopes, these racial aspirations, this great ideal, the great American ideal of life, liberty, and the pursuit of happiness? Millions of struggling people took on a new vitality during the war and putting their hope, their faith, and their trust in America fought on to a state of utter exhaustion.

Would you call out to a drowning man, "Don't give up, I'll save you," and after he had spent his strength in the struggle and you had brought him to the wharf, would you leave him helpless to be hurled back into the black abyss of despair by the first enemy that happens along? Would you leave him when his weakened condition is due to his faith in you? No, you would not. Not if you were an American and, thank God, I know what an American is to-day!

When I was a boy, and that wasn't very many years ago, I read of the glorious deeds of the men of Bunker Hill and Gettysburg and I was thrilled by their performance. Then I read that the Americans of to-day were mere slaves of greed, money grubbers, white and lily-livered. But to-day I know that the Americans of your blood and your generation know how to suffer and how to die and beside the men of Bunker Hill and Gettysburg can stand the men of Chateau Thierry and the Argonne Forest.

The League of Nations is not a question

of magnanimous philanthropy. It is a simple question of simple justice, and in this fight for justice we stake our leaders, Mr. Taft and President Lowell and the rest, against all their Reeds and all their Borahs, remembering as we do that " He is thrice armed who hath his quarrel just and he but naked though locked up in steel, whose conscience by injustice is corrupted."

A square deal to small peoples calls for the League of Nations now. We need the League as a part of that Treaty of Peace. We didn't fight this war to set up a mere truce; we deserve a peace worthy of our effort.

I can tell you in all truthfulness that America was not misrepresented on the fighting front. She couldn't afford to be — there was too much at stake. And there is too much at stake now, to have her misrepresented in the U. S. Senate. Are you going to allow her to be misrepresented in this great crisis of the world's history?

We owe it to those who are not going

to come back to set up a structure worthy of their sacrifice. They were enthused and fired to a pitch where death was not feared by the belief that this was a war for great principles, a war for democracy, a war to end war. One of the men who has a wooden cross in Flanders for a monument sent this challenge to each and every one of us just before he went down to his death:

In Flanders fields the poppies grow
Between the crosses, row on row,
That mark our place: and in the sky
The larks still bravely singing, fly
Scarce heard amid the guns below.

We are the Dead. Short days ago
We lived, felt dawn, saw sunset glow,
Loved, and were loved, and now we lie
In Flanders fields.

Take up our quarrel with the foe:
To you from failing hands we throw
The Torch: be yours to hold it high!
If ye break faith with us who die
We shall not sleep, though poppies grow
In Flanders fields.

COVENANT OF THE LEAGUE OF NATIONS

Adopted at the Plenary Session of the Interallied Peace Conference, April 28, 1919

In order to promote international coöperation and to achieve international peace and security, by the acceptance of obligations not to resort to war, by the prescription of open, just and honorable relations between nations, by the firm establishment of the understandings of international law as the actual rule of conduct among Governments, and by the maintenance of justice and a scrupulous respect for all treaty obligations in the dealings of organized peoples with one another, the high contracting parties agree to this Covenant of the League of Nations:

Article I

MEMBERSHIP AND WITHDRAWAL

1. The original members of the League of Nations shall be those of the signatories which are named in the annex to this Covenant and also

such of those other states named in the annex as shall accede without reservation to this Covenant. Such accessions shall be effected by a declaration deposited with the Secretariat within two months of the coming into force of the Covenant. Notice thereof shall be sent to all other members of the League.

2. Any fully self-governing state, dominion or colony not named in the annex may become a member of the League if its admission is agreed to by two-thirds of the Assembly, provided that it shall give effective guaranties of its sincere intention to observe its international obligations, and shall accept such regulations as may be prescribed by the League in regard to its military and naval forces and armaments.

3. Any member of the League may, after two years' notice of its intention so to do, withdraw from the League, provided that all its international obligations and all its obligations under this Covenant shall have been fulfilled at the time of its withdrawal.

Article II

EXECUTIVE ORGANS

1. The action of the League under this Covenant shall be effected through the instrumentality of an Assembly and of a Council, with a Permanent Secretariat.

Article III

ASSEMBLY

1. The Assembly shall consist of representatives of the members of the League.

2. The Assembly shall meet at stated intervals and from time to time as occasion may require, at the seat of the League, or at such other place as may be decided upon.

3. The Assembly may deal at its meetings with any matter within the sphere of action of the League or affecting the peace of the world.

4. At meetings of the Assembly each member of the League shall have one vote, and may not have more than three representatives.

Article IV

COUNCIL

1. The Council shall consist of representatives of the principal allied and associated powers, together with representatives of four other members of the League. These four members of the League shall be selected by the Assembly from time to time in its discretion. Until the appointment of the representatives of the four members of the League first selected by the Assembly, representatives of Belgium, Brazil, Greece and Spain shall be members of the Council.

2. With the approval of the majority of the

Assembly, the Council may name additional members of the League whose representatives shall always be members of the Council; the Council with like approval may increase the number of members of the League to be selected by the Assembly for representation on the Council.

3. The Council shall meet from time to time as occasion may require, and at least once a year, at the seat of the League, or at such other place as may be decided upon.

4. The Council may deal at its meetings with any matter within the sphere of action of the League or affecting the peace of the world.

5. Any member of the League not represented on the Council shall be invited to send a representative to sit as a member at any meeting of the Council during the consideration of matters specially affecting the interests of that member of the League.

6. At meetings of the Council each member of the League represented on the Council shall have one vote, and may have not more than one representative.

Article V

VOTING AND PROCEDURE

1. Except where otherwise expressly provided in this Covenant, or by the terms of the present treaty, decision at any meeting of the Assembly or of the Council shall require the agreement of

all the members of the League represented at the meeting.

2. All matters of procedure at meetings of the Assembly or the Council, including the appointment of committees to investigate particular matters, shall be regulated by the Assembly or by the Council and may be decided by a majority of the members of the League represented at the meeting.

3. The first meeting of the Assembly and the first meeting of the Council shall be summoned by the President of the United States of America.

Article VI

SECRETARIAT

1. The permanent Secretariat shall be established at the seat of the League. The Secretariat shall comprise a Secretary-General and such secretaries and staff as may be required.

2. The first Secretary-General shall be the person named in the annex; thereafter the Secretary-General shall be appointed by the Council with the approval of the majority of the Assembly.

3. The secretaries and the staff of the Secretariat shall be appointed by the Secretary-General with the approval of the Council.

4. The Secretary-General shall act in that capacity at all meetings of the Assembly and of the Council.

5. The expenses of the Secretariat shall be borne by the members of the League in accordance with the apportionment of the expenses of the International Bureau of the Universal Postal Union.

Article VII

SEAT, QUALIFICATIONS FOR OFFICIALS, IMMUNITIES

1. The seat of the League is established at Geneva.
2. The Council may at any time decide that the seat of the League shall be established elsewhere.
3. All positions under or connecting with the League, including the Secretariat, shall be open equally to men and women.
4. Representatives of the members of the League and officials of the League when engaged on the business of the League shall enjoy diplomatic privileges and immunities.
5. The buildings and other property occupied by the League or its officials or by representatives attending its meetings shall be inviolable.

Article VIII

REDUCTION OF ARMAMENTS

1. The members of the League recognize that the maintenance of peace requires the reduction

of national armaments to the lowest point consistent with national safety and the enforcement by common action of international obligations.

2. The Council, taking account of the geographical situation and circumstances of each state, shall formulate plans for such reductions for the consideration and action of the several Governments.

3. Such plans shall be subject to reconsideration and revision at least every 10 years.

4. After these plans shall have been adopted by the several Governments, limits or armaments therein fixed shall not be exceeded without the concurrence of the Council.

5. The members of the League agree that the manufacture by private enterprise of munitions and implements of war is open to grave objections. The Council shall advise how the evil effects attendant upon such manufacture can be prevented, due regard being had to the necessities of those members of the League which are not able to manufacture the munitions and implements of war necessary for their safety.

6. The members of the League undertake to interchange full and frank information as to the scale of their armaments, their military and naval programs, and the condition of such of their industries as are adaptable to warlike purposes.

Article IX

PERMANENT MILITARY COMMISSION

1. A permanent commission shall be constituted to advise the Council on the execution of the provisions of Articles I and VIII and on military and naval questions generally.

Article X

GUARANTIES AGAINST AGGRESSION

1. The members of the League undertake to respect and preserve as against external aggression the territorial integrity and existing political independence of all members of the League. In case of any such aggression or in case of any threat or danger of such aggression, the Council shall advise upon the means by which this obligation shall be fulfilled.

Article XI

ACTION IN CASE OF WAR OR THREAT OF WAR

1. Any war or threat of war, whether immediately affecting any of the members of the League or not, is hereby declared a matter of concern to the whole League, and the League shall take any action that may be deemed wise and effectual to safeguard the peace of nations. In case any such emergency should arise, the Secretary-General shall, on the request of any

member of the League, forthwith summon a meeting of the Council.

2. It is also declared to be the fundamental right of each member of the League to bring to the attention of the Assembly or of the Council any circumstance whatever affecting international relations which threatens to disturb international peace or the good understanding between nations upon which peace depends.

Article XII

DISPUTES TO BE SUBMITTED TO ARBITRATION OR INQUIRY

1. The members of the League agree that, if there should arise between them any dispute likely to lead to a rupture, they will submit the matter either to arbitration or to inquiry by the Council, and they agree in no case to resort to war until three months after the award by the arbitrators or the report by the Council.

2. In any case under this article the award of the arbitrators shall be made within a reasonable time, and the report of the Council shall be made within six months after the submission of the dispute.

Article XIII

ARBITRATION OF DISPUTES

1. The members of the League agree that, whenever any dispute shall exist between them

which they recognize to be suitable for submission to arbitration and which cannot be satisfactorily settled by diplomacy, they will submit the whole subject matter to arbitration.

2. Disputes as to the interpretation of a treaty, as to any question of international law, as to the existence of any fact which if established would constitute a breach of any international obligation, or as to the extent and nature of the reparation to be made for any such breach, are declared to be among those which are generally suitable for submission to arbitration.

3. For the consideration of any such dispute the court of arbitration to which the case is referred shall be the court agreed upon by the parties to the dispute or stipulated in any convention existing between them.

4. The members of the League agree that they will carry out in full good faith any award that may be rendered and that they will not resort to war against a member of the League which complies therewith. In the event of any failure to carry out such an award, the Council shall propose what steps should be taken to give effect thereto.

ARTICLE XIV

COURT OF INTERNATIONAL JUSTICE

1. The Council shall formulate and submit to the members of the League for adoption plans for the establishment of a permanent Court of International Justice. The court shall be competent to hear and determine any dispute of an international character which the parties thereto submit to it. The court may also give an advisory opinion upon any dispute or question referred to it by the Council or by the Assembly.

ARTICLE XV

DISPUTES NOT SUBMITTED TO ARBITRATION

1. If there should arise between members of the League any dispute likely to lead to a rupture, which is not submitted to arbitration in accordance with Article XIII, the members of the League agree that they will submit the matter to the Council. Any party to the dispute may effect such submission by giving notice of the existence of the dispute to the Secretary-General, who will make all necessary arrangements for a full investigation and consideration thereof. For this purpose the parties to the dispute will communicate to the Secretary-General, as promptly as possible, statements of their case, with all the relevant facts and papers; the Council may forthwith direct the publication thereof.

2. The Council shall endeavor to effect a settlement of the dispute and, if such efforts are successful, a statement shall be made public giving such facts and explanations regarding the dispute and terms of settlement thereof as the Council may deem appropriate.

3. If the dispute is not thus settled, the Council either unanimously or by a majority vote shall make and publish a report containing a statement of the facts of the dispute and the recommendations which are deemed just and proper in regard thereto.

4. Any member of the League represented on the Council may make public a statement of the facts of the dispute and of its conclusions regarding the same.

5. If a report by the Council is unanimously agreed to by the members thereof other than the representatives of one or more of the parties to the dispute, the members of the League agree that they will not go to war with any party to the dispute which complies with the recommendation of the report.

6. If the Council fails to reach a report which is unanimously agreed to by the members thereof, other than the representatives of one or more of the parties to the dispute, the members of the League reserve to themselves the right to take such action as they shall consider necessary for the maintenace of right and justice.

7. If the dispute between the parties is claimed

by one of them, and is found by the Council to arise out of a matter which by international law is solely within the domestic jurisdiction of that party, the Council shall so report and shall make no recommendation as to its settlement.

8. The Council may in any case under this article refer the dispute to the Assembly. The dispute shall be so referred at the request of either party to the dispute, provided that such request is made within 14 days after the submission of the dispute to the Council.

9. In any case referred to the Assembly, all the provisions of this article and of Article XII relating to the action and powers of the Council shall apply to the action and powers of the Assembly, provided that a report made by the Assembly, if concurred in by the representatives of those members of the League represented on the Council and of a majority of the other members of the League, exclusive in each case of the representatives of the parties to the dispute, shall have the same force as a report by the Council concurred in by all the members thereof other than the representatives of one or more of the parties to the dispute.

Article XVI

SANCTIONS

1. Should any member of the League resort to war in disregard of its covenants under Ar-

ticles XII, XIII and XV, it shall *ipso facto* be deemed to have committed an act of war against all other members of the League, which hereby undertake immediately to subject it to the severance of all trade or financial relations, the prohibition of all intercourse between their nationals and the nationals of the covenant-breaking state and the prevention of all financial, commercial or personal intercourse between the nationals of the covenant-breaking state and the nationals of any other state, whether a member of the League or not.

2. It shall be the duty of the Council in such case to recommend to the several Governments concerned what effective military or naval force the members of the League shall severally contribute to the armed forces to be used to protect the covenants of the League.

3. The members of the League agree, further, that they will mutually support one another in the financial and economic measures which are taken under this article, in order to minimize the loss and inconvenience resulting from the above measures, and that they will mutually support one another in resisting any special measures aimed at one of their number by the covenant-breaking state of the League, and that they will take the necessary steps to afford passage through their territory to the forces of any of the members of the League which are coöperating to protect the covenants of the League.

4. Any member of the League which has violated any covenant of the League may be declared to be no longer a member of the League by a vote of the Council concurred in by the representatives of all the members of the League represented thereon.

Article XVII

DISPUTES WITH NON-MEMBERS

1. In the event of a dispute between a member of the League and a state which is not a member of the League, or between states not members of the League, the state or states not members of the League shall be invited to accept the obligations and membership in the League for the purposes of such dispute upon such conditions as the Council may deem just. If such invitation is accepted, the provisions of Articles XII to XVI inclusive shall be applied, with such modifications as may be deemed necessary by the Council.

2. Upon such invitation being given, the Council shall immediately institute an inquiry into the circumstances of the dispute and recommend such action as may seem best and most effectual in the circumstances.

3. If a state so invited shall refuse to accept the obligations of membership in the League for the purposes of such dispute, and shall resort to war against a member of the League, the pro-

visions of Article XVI shall be applicable as against the state taking such action.

4. If both parties to the dispute, when so invited, refuse to accept the obligations of membership in the League for the purposes of such dispute, the Council may take such measures and make such recommendations as will prevent hostilities and will result in the settlement of the dispute.

ARTICLE XVIII

REGISTRATION AND PUBLICATION OF TREATIES

1. Every treaty or international engagement entered into hereafter by any member of the League shall be forthwith registered with the Secretariat and shall as soon as possible be published by it. No such treaty or international engagement shall be binding until so registered.

ARTICLE XIX

REVIEW OF TREATIES

1. The Assembly may from time to time advise the reconsideration by members of the League of treaties which have become inapplicable, and the consideration of international conditions whose continuance might endanger the peace of the world.

ARTICLE XX

ABROGATION OF INCONSISTENT OBLIGATIONS

1. The members of the League severally agree that this Covenant is accepted as abrogating all obligations or understandings *inter se* which are inconsistent with the terms thereof, and solemnly undertake that they will not hereafter enter into any engagements inconsistent with the terms thereof.

2. In case any member of the League shall, before becoming a member of the League, have undertaken any obligations inconsistent with terms of this Covenant, it shall be the duty of such member to take immediate steps to procure its release from such obligations.

ARTICLE XXI

ENGAGEMENTS THAT REMAIN VALID

1. Nothing in this Covenant shall be deemed to affect the validity of international engagements, such as treaties of arbitration or regional understandings like the Monroe Doctrine, for securing the maintenance of peace.

ARTICLE XXII

CONTROL OF COLONIES AND TERRITORIES

1. To those colonies and territories which as a consequence of the late war have ceased to be

under the sovereignty of the states which formerly governed them and which are inhabited by peoples not yet able to stand by themselves under the strenuous conditions of the modern world, there should be applied the principle that the well being and development of such peoples' performance of this trust should be embodied in this Covenant.

2. The best method of giving practicable effect to this principle is that the tutelage of such people be intrusted to advanced nations who, by reason of their resources, their experience or their geographical position, can best undertake this responsibility and who are willing to accept it, and that this tutelage should be exercised by them as mandataries on behalf of the League.

3. The character of the mandate must differ according to the stage of the development of the people, the geographical situation of the territory, its economic conditions and other similar circumstances.

4. Certain communities formerly belonging to the Turkish Empire have reached a stage of development where their existence as independent nations can be provisionally recognized subject to the rendering of administrative advice and assistance by a mandatary until such time as they are able to stand alone. The wishes of these communities must be a principal consideration in the selection of the mandatary.

5. Other peoples, especially those of Central Africa, are at such a stage that the mandatary must be responsible for the administration of the territory under conditions which will guarantee freedom of conscience and religion, subject only to the maintenance of public order and morals, the prohibition of abuses such as the slave trade, the arms traffic and the liquor traffic, and the prevention of the establishment of fortifications or military and naval bases and of military training of the natives for other than police purposes and the defense of territory, and will also secure equal opportunities for the trade and commerce of other members of the League.

6. There are territories, such as Southwest Africa and certain of the South Pacific islands, which, owing to the sparseness of their population or their small size, or their remoteness from the centers of civilization, or their geographical contiguity to the territory of the mandatary, and other circumstances, can be best administered under the laws of the mandatary as integral portions of its territory, subject to the safeguards above mentioned in the interests of the indigenous population.

7. In every case of mandate the mandatary shall render the Council an annual report in reference to the territory committed to his charge.

8. The degree of authority, control or administration to be exercised by the mandatary shall,

if not previously agreed upon by the members of the League, be explicitly defined in each case by the Council.

9. A permanent commission shall be constituted to receive and examine the annual reports of the mandataries, and to advise the Council on all matters relating to the observance of the mandates.

Article XXIII

SOCIAL ACTIVITIES

1. Subject to and in accordance with the provisions of international conventions existing or hereafter to be agreed upon, the members of the League:

(a) will endeavor to secure and maintain fair and humane conditions of labor for men, women and children, both in their own countries and in all countries to which their commercial and industrial relations extend, and for that purpose will establish and maintain the necessary international organizations;

(b) undertake to secure just treatment of the native inhabitants of territories under their control;

(c) will intrust the League with the general supervision over the execution of agreements with regard to the traffic in women and children and the traffic in opium and other dangerous drugs;

(d) will intrust the League with the general supervision of the trade in arms and ammunition with the countries in which the control of this traffic is necessary in the common interest;

(e) will make provision to secure and maintain freedom of communication and of transit and equitable treatment for the commerce of all members of the League. In this connection the special necessities of the regions devastated during the war of 1914–1918 shall be in mind;

(f) will endeavor to take steps in matters of international concern for the prevention and control of disease.

Article XXIV

INTERNATIONAL BUREAUS

1. There shall be placed under the direction of the League all International Bureaus already established by general treaties, if the parties to such treaties consent. All such International Bureaus and all Commissions for the regulation of matters of international interest hereafter constituted shall be placed under the direction of the League.

2. In all matters of international interest which are regulated by general conventions but which are not placed under the control of international bureaus or commissions, the Secretariat of the League shall, subject to the consent of the Council and if desired by the parties, collect and dis-

tribute all relevant information and shall render any other assistance which may be necessary or desirable.

3. The Council may include as part of the expenses of the Secretariat the expenses of any Bureau or Commission which is placed under the direction of the League.

Article XXV

PROMOTION OF RED CROSS

1. The members of the League agree to encourage and promote the establishment and co-operation of duly authorized voluntary national Red Cross organizations having as purposes improvement of health, the prevention of disease and the mitigation of suffering throughout the world.

Article XXVI

AMENDMENT

1. Amendments to this Covenant will take effect when ratified by the members of the League whose representatives compose the Council and by a majority of the members of the League whose representatives compose the Assembly.

2. No such amendment shall bind any member of the League which signifies its dissent therefrom, but in that case it shall cease to be a member of the League.

ANNEX

I. Original members of the League of Nations, signatories of the treaty of peace:

United States of America	Haiti
Belgium	Hedjaz
Bolivia	Honduras
Brazil	Italy
British Empire	Japan
Canada	Liberia
Australia	Nicaragua
South Africa	Panama
New Zealand	Peru
India	Poland
China	Portugal
Cuba	Rumania
Czecho-Slovakia	Serb-Croat and Slovene State
Ecuador	Siam
France	Uruguay
Greece	
Guatemala	

States invited to accede to the Covenant:

Argentine Republic	Denmark
Chile	Netherlands
Colombia	Norway

Paraguay
Persia
Salvador
Spain
Sweden
Switzerland
Venezuela

II. First Secretary-General of the League of Nations: Sir James Eric Drummond.

THE UNIVERSITY AND WORLD ORGANIZATION

PUBLISHED IN THE DAILY CALIFORNIAN, JANUARY 27, 1919

These are great days in which to be alive. Better than some others we have known.

The first steps have been taken toward a realization of the great principles which have bound millions of Allied soldiers together in a determined struggle. But these principles still remain as a challenge to those who have it within their power to translate ideals into action, still remain as principles merely, as yet unrealized.

With the disbanding of the armed millions we are conscious of another and far greater army, the great army of public opinion which is destined to rule the world. In that army the universities are the generals and we as students at the university are responsible for our generalship.

Our position is peculiar for several reasons. In the first place, opinions, political institutions, nations and races are in a state of flux. Governments which have ruled for years are being shattered and wrecked. Subject peoples find now

their first opportunity to assert themselves. Political organisms the world over are changing with a rapidity heretofore unknown. The England of to-day is not the England of 1913, and this is true also of France, Italy and, to a smaller extent, the United States.

Because the flood of political opinion is rolling high we have a good opportunity to accomplish a much needed international political organization. Internationally we are in a state of anarchy. The very term international law is a delusion and a snare. It is a rank misnomer. Law is a rule of action supported by a sanction, and there can be no law without such sanction. An international organization that could give us international law is as yet unborn.

In the second place, the position of the United States at the peace table is one of peculiar power. "We have no selfish ends to serve," and for that very reason, while others will be forced to make concessions to gain the territorial and other material advantages which they seek, we can stand firmly for the accomplishment of our high purpose.

Lastly, the position and responsibility of one so fortunate as to be a university student at this critical period in the world's history is peculiar. We have every facility for an advance with the first wave. The zero hour is at hand. We have the library. We have the daily papers. We must read what Wilson, Lloyd George, Clemen-

ceau, Orlando and Venizelos are saying. These men speak with the consciousness that they represent millions and that they hold the destinies of people in the palms of their hands. We can't afford to miss what Professor Henry Morse Stephens is saying in the "War Issues" course. We may find courses in the Political Science department where a leisure hour can be spent quite as profitably as before the fraternal hearth. This is not the place to drift with the current of opinion: it is the place from which the course of those currents should be directed.

There is no problem so important as that of political organization for the world. War represents a relapse of civilization to a state of barbarism and never can we reach that higher civilization with the necessary concomitants of better social and industrial conditions until we devise the machinery for the prevention of these periodic relapses.

We may be pardoned for believing that a perfected international government is a considerable distance in the future, but we can not be pardoned for being without thought on a problem so important. This for consideration: — peace follows justice; justice follows law; law follows political organization.

LETTER FROM A WOUNDED SOLDIER

To the Editor of The New York Times:

To those who oppose the proposed League of Nations, either because they are not in favor of the policies of our President (which would be very narrow minded of them), or because of some other reason, and who were unable to be in a battle, I address the following:

You who have never seen the horrors of war, who have never seen a man disappear, literally blown to atoms, on being struck by a shell; who have never heard the shrieks of wounded human beings, who have never heard the hysterical laughter of a man as he gazes at the stump where his hand was a moment ago, who have never heard the cries, the groans, the swearing, the praying of men with festering wounds, lying in a first aid station, waiting too long and in vain for ambulances; who have never witnessed the terror of those men when the station is gassed and there are no gas masks, who have never seen convalescents, totally blind and with both hands amputated above the wrists—can you say that we should stop at anything in order to prevent this

frightfulness, this savagery, this horror from occurring again? Is there any other way than by a League of Nations and combination of power? Will a simple treaty among the greater nations prevent a recurrence of such an attempt as Germany has made? Is not the League of Nations, as proposed, elastic enough and broad enough, whatever its defects, to insure world peace? Is it not a step, and the only possible step, in the right direction? I firmly believe so. If there is another way, speak it out. If not, for God's sake, stop opposing this one remedy.

WYMAN RICHARDSON,
(Wounded in action.)

Boston, March 18, 1919.

PRINTED IN THE UNITED STATES OF AMERICA

On its southern flank the rock is more micaceous, and Mr. E. J. S. Hoch, of Topton, has recently reported a shaft 16 feet deep on John Kemp's farm, ½ mile south of Huff Church, which showed a 1 foot bed of mica contained between a syenite and blue (orthoclase) feldspar walls. Samples of the mica sent me show some good plates of Muscovite or light mica, though of not sufficient clearness or size to be of any commercial value. Mr. Hoch reports several smaller beds a few inches thick at the same locality.

The same rocks just described show in Devil Head hill west of creek.

Near Mensch's old mill dam, there is an exposure of syenite on each side of creek, 20 to 30 feet thick dipping N. 13° W. 30°, and further north at cross-roads an exposure of rotten gneiss dipping N. 30° W. 55°.

From Huff church west along road, the same hornblendic gneiss very much decomposed to a dull red earth, is exposed at roadside just west of the church. No dip was discernible. A 40-foot test hole was put down in field, with no very encouraging success, passing mostly through rather ferruginous hornblendic gneiss. A finely laminated grey micaceous gneiss is seen in places on south side of road, outcropping prominently in field on property of N. Beidler, in District township, dipping S. 55° E. 83°. Exposure is probably 30 feet thick. This rock continues to Perkiomen Creek, at Benfield's Mill, where Potsdam is again met with, forming the north limit of this gneiss belt.

The hills to the south as far as the second branch of the Perkiomen are all composed of similar rock. These hills have mostly been cleared, and the boulders used in the construction of fences. With the aid of burnt lime from the Dale Forge quarries, the region is capable of high cultivation.

The remaining portion of this belt is confined between the waters of Pine and Manatawny creeks, and as measured along the District-Pike township line is about 2400 yards wide.

Passing north from Landis' store the road passes over a

hill of blue syenitic gneiss, which has been opened on north flank of hill for iron ore.

An old engine-house was still standing there, but the mine had evidently been abandoned for some time, and no information as to its former production could be obtained.

About a mile N. W. from here along road there is another opening on land of P. Steiner, known as the Trexler Mine. It was also idle at time of inspection, but showed a 40-foot shaft down in gneiss, from which some very fair magnetic iron ore had been taken.

The continuation of this hill S. W. across road displays immense syenite boulders 40 feet high along the crest, spreading down flank of hill to mill dam.

Pine creek here skirts the north side of a folded anticlinal, which sinking S. W. under the Oley Valley, receives both sandstone and limestone on its western extension. Two hundred yards south of the mill and on south side of stream, dark syenite outcrops in places, dipping S. 50° E. 35°

East of this locality and higher up on hill summit north of Lewis Rohrbach's house, there is an abandoned mine which is reported to have been formerly worked by a shaft 100′ deep and a tunnel 150′ long into hill on a 12-foot bed of ore. This was one of the sources of supply for the old Heilig's Forge, which used to stand on Pine creek near mill dam mentioned above, and where until quite recently a number of tons of ore remained to mark the spot. Again, 300 yards S. W. of the old forge, gneiss outcrops in small nose crossing road, dipping S. 10° E. 53°, rather more feldspathic in character. Potsdam sandstone soon appears on the creek and swings S. W. around nose of hill to join the Manatawny deposit.

A small strip of gneiss, however, comes in along south flank of this hill, starting out from main range and terminating on road crossing hill south of St. Paul's church, and dipping about 300 yards S. E. of church on road, S. 55° E. 70°.

Going up road N. E. from Pikeville, Potsdam spreads up cove between hills to about an elevation of 600′ A. T.,

when it is succeeded by a hornblendic gneiss, dipping at limekiln on road S. 20° E. 35°. Gneiss then spreads all over the hills and valleys to the north of this locality, showing but few exposures.

One outcrop about 10′ thick shows in place on Pine creek, near C. Miller's place, dipping S. 45° E. 45°, and south east from this locality, where small road up branch stream meets the main road at S. Yoder's house, mining for magnetic iron ore has been carried on through a number of years, though no very definite information as to the quantity or quality of the ore mined could be obtained.

The openings are located on property of Lewis Rohrbach, and consist of two open cuts on the outcrop, and two tunnels driven in from each road at right angles to each other.

No work has been done here for 7 or 8 years, the last operator being the Clymer Iron Co.

The old Rockland forges were formerly largely supplied with this ore.

A small exposure of micaceous gneiss occurs here, dipping S. 60° E. 50°. Large gneiss boulders mark the summit of the hill about three hundred yards due west of S. Yoder's, constituting a prominent landmark.

Going south-east over hill from Yoder's place past H. Adams' house, and north-east along south flank of hill, all the country is covered with granulite boulders, though one small exposure of feldspathic quartzose gneiss shows at A. Weller's house, dipping N. 85° E. 60°, and gneiss of the same character extends as boulders south-east down road from P. Weller's house to within fifty feet of Manatawny creek.

Along crest of range, syenite is seen outcropping just at nose of rise at road crossing at contour 970′, dipping S. 32° E. 40°. The exposure is about 25′ thick, and is accompanied by a great mass of boulders, left exposed by the clearing of the hill by charcoal burners.

North of P. Weller's house, about one half mile S. E. from last locality, a laminated grey micaceous gneiss is exposed in roadside, dipping S. 45° E. 55°, succeeded N. E. towards Landis' store by blue syenite boulders, very hard

and angular, and occupying the rest of the country as far south as the head-waters of the Manatawny creek.

Second Division of Southern Gneiss Belt.

The northern-eastern limit of this last division is marked by the narrow tongue of Potsdam sandstone along road running up the branch of Perkiomen creek from Claytonville towards Huff church, known as the "Devil's Hole" road. There is but a small patch of gneiss in this range in Hereford township. Spreading from thère S. W. through Washington to Earl, bounded on the north by the Potsdam belt already referred to, and on the south *generally* by the narrow Magnesian limestone valley lying between the south base of the South Mountains and the Mesozoic formation.

The large hill to the east of the Dale Forge limestone valley, marking the N. E. extension of the range, shows along road from A. Gerhart's place, S. W. up hill, a white quartzose feldspathic gneiss in large angular boulders, but nowhere seen in place.

On summit, at M. Stengle's place, there are immense boulders of a fine-grained grey compact gneiss, excellent for building purposes and foundation walls, which continues down towards Clayton road as far as creek-crossing at A. Stauffer's place, where Potsdam is met with.

From Churchville north up hill road, Potsdam sandstone occupies south flank of hill as far as small knoll east of Kuhn's place, above which the Laurentian rocks appear at about 700′ contour, with a dip of S. 15° E. 45° ; here rather characterized by hornblende, which rock seems to occur all over the hill to the *south* of the road as far as the West Branch of the Perkiomen creek.

The Sparr and Eline mines are opened in this rock, the lighter variety lying to the north.

From Barto up creek to Dale Forge several good exposures are seen.

Passing the old Mt. Pleasant forge, which is close to the junction of Potsdam sandstone and gneiss, in the first knoll on right bank of creek going north, just opposite Latshaw's

mill, there is a first exposure of 10′ of feldspathic gneiss dipping S. 50° E. 35°, succeeded in 50 feet in same hill by an hornblendic variety with a dip of S. 55° E. 40°.

The next outcrop is seen back of saw-mill near J. Huber's house on west side of creek, here a decomposed jointed exposure 40 feet thick, composed of hornblendic syenite and epidote, dipping S. 10 E. 40°.

North from this, feldspathic gneiss with large quartz veins is seen in hill-cut back of barn, dipping S. 38° E. 50°.

There are indications of a small anticlinal roll here, as the dip 100′ above this last exposure is N. 10° E. 60°, though again changing to a south-east dip at mill-dam.

This last exposure is a prominent one, extending for 125′ along road, and represented in hillside on west side of creek just below dam. The whole exposure is very much jointed and in places decomposed. The dips are rendered doubtful owing to excessive cleavage.

The variety furthest south is a blue syenite, very hard, dipping S. 65° W. 50° (?) just at turn of road, and the second, more feldspathic and decomposed, a little further north and higher up hill, S. 62° W. 70°.

This outcrop continues around bend of road dipping again normally near creek crossing S. 35° E. 60°.

Boulders of gneiss continue up road to within 500 feet of Dale Forge hotel, where No. II magnesian limestone is met with.

From Barto Station up hill towards Landis' store, blue and black syenite boulders are seen along road and in fields, gradually blending into a light-colored gneiss of a more feldspathic character.

The division is sharpest in cove just east of A. Miller's house. The ridge west of Miller's, around which the road curves, is composed of light-colored gneiss with prominent crystals of soda feldspar.

So prominent are these nodules of basic feldspar, that in the titaniferous magnetic iron ores occurring along this range as far as Bechtelsville—at the Gilbert, Lewis, and Nestor mines—it constitutes fully fifty per cent. of the gangue, entering also largely into the ore body itself.

It is the rock-mass of the bulk of the country between the Perkiomen creek and Swamp creek, and shows dips one quarter mile south of Nestor's mine on summit of hill of S. 70°-80° E. 30°-35°; at Gilbert's mine S. 60° E. 38°, and on road above A. Miller's S. 65° E. 40°.

The country just west of Barto, and especially in the neighborhood of the mines, shows a syenite, with dips along Eshbachville road of S. 15° E. 45° at Mt. Pleasant mine; S. 25° E. 50° above Deisher's house; and S. 10° E. 65° on branch creek one half mile north of Eshbachville.

Going up north branch of Swamp creek from Bechtelsville, the dip of gneiss at the Stouffer mine appears to be to the west 60° to 65°. North of Reidenhauer's saw mill, granulite gneiss outcrops in hillside near school-house, dipping S. 87° E. 38°, exposure about 12′ thick, and again just above Cummener's mill about 50′ of hornblendic gneiss, dipping S. 35° E. 38°, greatly jointed and disintegrated.

Turning west off the road near head of valley to C. Miller's and A. Weller's, the rock boulders on west side of creek become very hornblendic producing, when decomposed, the characteristic brown-red soil as far as school-house on summit 1020′, above Becker's house.

At Weller's, the dip is S. 18° E. 46°. This rock covers most of the country to the north in the southern corner of District township, occurring as huge boulders on the wide flats dividing the Perkiomen waters from those of the Manatawny creek, and showing in place on road north of J. Heydt's house, dipping S. 70° E. 50°.

West of the Landis store road, along the head-waters of the Manatawny, especially in the neighborhood of the Hoffman shafts, a thin coating about 4′ thick of Potsdam sandstone spreads over the gneiss floor, which has been uncovered in several places in the numerous trial shafts seen there.

That part of Pike township between the District line and the Hill church road is composed generally of a granular mixture of coarse feldspar and quartz, though still firm and but little decomposed.

Rolling Stone hill shows one exposure of this rock, dipping close to the edge of the Potsdam sandstone N. 25° W. 40°, duplicated on road south-west one half mile, near J. Moyer's house, by a dip of same rock S. 40° E. 20°, marking the south leg of the anticlinal passing through here.

The road from Bechtelsville to Hill Church along *north* side of stream is all in gneiss, mostly typical, being an intimate mixture of quartz, feldspar, and mica, the regular and even weathering of which has given the rounded appearance to the hills north of the stream, whilst the dissolution of the feldspar has given rise to a very sandy soil, composed of quartz and shiny scales of black mica.

Not so, however, is the country to the *south* of the stream, which a glance at the topography will show consists of a very different rock.

A belt of hornblendic rock of great coarseness comes in here, which has better resisted the weathering, and consequently the hills show bolder and steeper slopes.

No sharp division line is possible, however, for there are exceptions on both sides of the creek to the foregoing statement.

At an old mine hole close to public road, and about 500 yards S. S. W. of J. Dotterer's house, there is a large pile of rock, called by the miners "Black Jack ore," from the deceptive similarity in color to magnetic iron ore.

A small covering of 20 to 25 feet of light-colored micaceous gneiss seems to occur on top of this black rock, which shows a coarse crystallization of hornblende, making up the whole mass of the rock; very hard, heavy, and showing perfect cleavage joints.

Several tons of this stuff were removed in hopes of its being magnetic iron ore. At the shaft the dip is N. 85° E. 65°, and 100 yards further south N. 70° E. 55°.

The same rock shows on small summit 1 mile N. W. of Bechtelsville dipping in road cut S. 20° E. 60°.

The Hill Church road, in the neighborhood of L. Swavely's place, shows gneiss boulders for a ½ mile with a distinctly blue coloring, especially on the surface, but generally disseminated through the mass.

This coloring seems to be local, and is confined to a comparatively small area along north side of creek.

Mr. McCreath's rough analysis shows it to belong to the amphibole group of minerals, being a silicate of alumina, iron, lime, and magnesia. A portion of the mass, more or less mixed with feldspar, gives SiO_2 51.70; Al_2O_3 17.543; FeO 9.221; CaO 5.060; MgO 8.765; undetermined, 7.711.

The rock is distinctly hornblendic, though carrying above the average percentage of quartz and feldspar.

There is an abandoned ore shaft near here on road in hornblendic gneiss, though it never seems to have yielded any ore. Several other small test-holes have been put down on the road between here and Hill Church.

South from Hill Church, between the Ironstone Creek and the limestone valley, along the base of the mountain, the country becomes more and more rounded and broken up as we proceed south, owing to the imperceptible but gradual change in the rock mass from an almost pure hornblende to almost pure feldspar. The rapid decomposition of the latter rock gives rise to the rounded topography of Colebrookdale township, so similar to that already mentioned in Exeter township.

Between Hill Church and the Colebrookdale line, on Ironstone Creek, the hornblendic variety predominates, and even shows at nose of hill in Colebrookdale township, at Grim's Steam Mill, dipping about N. 30° E. 50°, in an exposure 20′ thick, jointed and decomposed.

Just beyond mill, along road, the dip is about S. 35° E. 48°, succeeded further south in small knoll on road, by dips of quartzose and feldspathic gneiss of N. 30° W. 10°, and S. 10° W. 30°, though owing to excessive decomposition these dips are unreliable. These are the last exposures seen as far as Boyertown, the intervening country being covered with a deep soil and under a high state of cultivation. Mica becomes more prominent as a rock constituent in this part of the range, and in the two graphite holes opened at Dr. Funk's Fish Pond and on J. Bechtel's place, the graphite scales occur, disseminated through a distinctly micaceous gneiss.

Some considerable development has been done in the latter place, situated about one and a half miles west of Boyertown in field on property of J. Bechtel. Several specimens were collected at the abandoned hole, which is about thirty feet deep, all showing small graphite plates occurring in gneiss and sometimes as seams in quartz rock.

Commercially, both this deposit and the one one half mile nearer Boyertown, at Dr. Funk's place, are of little value.

Ferruginous mica schist outcrops on public road north of J. Bechtel's house, dipping S. 65° W. 40°, and again on hill about one half mile N. E. from here S. 30° E. 10°.

Sandy micaceous gneiss spreads over the entire north portion of Colebrookdale township, with the exception of the two parallel hills already noted on the Ironstone creek north of Grim's mill, which show the reddish-brown soil derived from their hornblendic rock.

Quartzose gneiss is largely mixed with the hornblendic variety north of the Furnace creek, in southern Pike and northern Earl, specially confined to the hill north-west of Shanesville, in the neighborhood of Cleaver's abandoned iron mine, where a black hornblende is mixedwith a tough magnetite.

Potsdam occupies the crest and west flank of Shenkel's hill, but east of this, along road and through hills to the Colebrookdale line, all is a feldspathic gneiss, with the exception just mentioned.

On Furnace creek, close to the junction of Potsdam in Shenkel's hill, gneiss appears, dipping N. 65° E. 60°, about 10′ thick. This rock outcrops in several places in the next two hundred feet towards Shanesville, generally feldspathic, but occasionally carrying some hornblende also, finally dipping S. 64° E. 36°.

Three hundred feet further east the dip is S. 40° E. 70° just where the road crosses over small hill.

All these outcrops show considerable decomposition, due to their feldspathic character.

From old mill dam south-east towards Shanesville gneiss

sticks out in several places along hill.side with about the the same average dip.

The remaining areas of gneiss in Earl and a small portion of Colebrookdale townships can be best located by reference to the Index Map, for in the series of closely-folded anticlinals and synclinals in this dying part of the range, the gneiss plays a subordinate part to the Potsdam sandstone, which everywhere rises up the west flank, and occasionally over the crest of these hills, as well as occurring in the included valleys. Most of the gneiss is completely covered, but patches have been left exposed here and there, especially on the east flank of the hills, which proves its presence at no great depth.

The whole east side of Shenkel's Hill is gneiss, Potsdam lying on crest and west flank, and branching out in various arms up the streams, at the base of the hill.

On road from Spangsville to Shanesville, and a short distance above Drumheller's place, there is an outcrop of almost pure orthoclase feldspar at roadside, containing a little mica as an accessory constituent, but entirely free of quartz. The dip is S. 30° E. 30°.

The road north of this and the side hill to the west of road is covered with scales of Muscovite mica, mostly of a yellow and green tint, though no outcrop in place could found. A hole was said to have been dug in hill, exposing some fair mica, but as the soil here seemed especially adapted to the growth of a slender but bushy pine, a hunt for its location was rendered fruitless.

Towards crest of hill up road hornblende plays a more prominent part in the composition of the rock mass, and as this increases the growth of pine becomes more stunted and scattered.

The Potsdam soil on the other side of the hill, as well as throughout the district, seems best adapted to the growth of chestnut and some little oak, which have been largely cleared for burning charcoal.

The rounded hill south of H. Kaufman's place, and similar smaller ones between the two public roads back of Furnace

Hill, are composed of a feldspathic gneiss, and mark the northern extension of the Saenger's Hill anticlinal.

There is one exposure of gneiss on the first hill, near the summit, dipping S. 30° E. 70°, which is an overturned dip.

Another patch of gneiss may be seen at the west base of Long Hill, extending S. W. up cove on *east* side of creek, nearly to the public road, and spreading N. E. into the main body of gneiss around Shanesville.

All these hills are essentially made up of a feldspathic gneiss, and being cleared, rounded, and elevated, they present a beautiful contrast to the more rugged and wooded Potsdam hills to the south.

A small exposure of gneiss occurs just west of the public road on the east flank of Mengle's Hill, and the boulders there seem to be rather hornblendic.

The ridge of gneiss included between Long Hill and Fancy Hill, and extending from the forks of Trout Run N. E. into Colebrookdale township, is decidedly hornblendic, and shows everywhere a hard syenite, with fully 70 per cent. hornblende. An opening was made close to the forks of the creek, in summit of same hill, which has only furnished "Black Jack ore."

The soil is darkly stained to a red-brown color, and the rock is slightly magnetic.

A long strip of feldspathic gneiss is found flanking the east side of Fancy Hill from near Earlville into Colebrookdale township, and divides that hill from Sand Hill.

The latter shows similarly gneiss on its eastern flank, though the large mass of Potsdam sandstone, extending from the Douglass-Colebrookdale line north of the Reading road to Earlville, covers Sand Hill nearly up to the 700′ contour, and rises on the crest from the S. W. over the branch of Ironstone creek.

All the gneiss hills west of Ironstone creek in Colebrookdale township are feldspathic in character, with the exception of the rather prominent ridge extending N. E. from J. M. Bahr's place. This is hornblendic, and on the road at the western base close to creek a slightly magnetic decomposed syenite occurs in plates, dipping apparently N.

42° W. 50°–70°, though with prominent south-dipping cleavage planes.

It outcrops in several places along road, extends up hill, and is probably 60 feet thick. The soil is red. On the opposite side of the creek the gneiss is decidedly feldspathic, shows no hornblende, and carries a little mica.

One more dip is to be recorded in this southern range, showing on public road leading up hill from Reading road, about 1 mile N. E. of Greshville, where, close to the junction of No. 1, quartzose gneiss dips apparently to the west 50°. The exposure is small and obscure.

The various junctions of gneiss with sandstone, limestone, and red shale, will all be noted in the chapters on those formations.

CHAPTER IV.

Potsdam Sandstone. No. 1.

It would be safer to name this formation the *Reading Sandstone;* but in the descriptions of its outcrops along the Little Lehigh, the Lehigh and the Delaware rivers, in Vol. I of this report, it has been called *Potsdam Sandstone*, taking for granted that any sand formation underneath the Magnesian limestones of the Great Valley must be the same sand formation which in Northern New York underlies the Corniferous, Chazy and other limestones of the Mohawk valley.

In the Final Report of the First Geological Survey of Pennsylvania, published in 1858, Professor Rogers called it the "*Primal White Sandstone*," and the slate beds above and beneath it, he called "*Upper*" and "*Lower Primal Slate;*"—the word *Primal* being intended to express the fact that this sandstone and these slates are the bottom, base, or commencement of the great Palæozoic system of rock formations which make up the great part of Pennsylvania; the top of the system being the coal formation.*

Underneath the *Primal lower slate* Prof. Rogers describes a *Lower sandstone* or *conglomerate;* but neither this nor his *Lower Primal slate* can be recognized in Berks county. In fact the whole formation, which is many thousand feet

* This report is not the place to discuss the difficult questions which have arisen respecting systems of formations which have been found to lie between the Laurentian and Palæozoic—such as the so-called Huronian, Cambrian, Taconic, &c. It is only necessary to say here that if the Berks county gneiss be Laurentian, then such intermediate systems have no existence in Berks county: for the Potsdam sandstone lies directly upon the gneiss. But as it does not lie always, or perhaps often, *conformably* upon the gneiss, there must have been a break in the order of deposits, and a length of time during which any number of formations may have been deposited in other parts of America.

thick in the Southern States, has dwindled to about 300 feet before we reach the Schuylkill river, and seems to be even still thinner on the Lehigh. The Conglomerate described by Prof. Prime, at H. Seller's quarries, east of East Penn Junction, in Lehigh county, (Vol. I, p. 206,) is one of the lower beds of the Reading sandstone, and no *lower primal slate* lies between it and the gneiss.

In many places in Berks county the lowest bed of the sandstone, always seen resting on the gneiss, is a coarse conglomerate of angular quartz rock-fragments, of all sizes, in a silicious paste. This sort of breccia is found along the crests of the Earl township hills, which are of gneiss faced or veneered with sandstone; conspicuous in the backbone of Saw-Mill hill; and in the footwall of the Dotterer red hematite mine, the ore being in a conformably overlying clay slate. Usually the pebbles are too small and sharp to justify the use of the word *conglomerate;* although, for convenience, the rock has been called a *gneissic conglomerate* in this report. The term *sub-Potsdam conglomerate* would express its position underneath the *Potsdam quartzite white sandstone proper*, belonging to it by conformity, and separated from the gneiss by nonconformity.

The *Potsdam white sandstone* cannot be considered a persistent formation throughout Berks county *at the surface;* for it occurs in patches lying against the gneissic mountain sides; yet these patches are remnants of a formation which had a wide extent, and no doubt spreads more or less continuously but irregularly beneath the limestone and slate regions of the Great Valley. They are so much alike; the sandstone is so easily recognizable everywhere that there can be no doubt of their common origin and former far wider spread. And, in fact, there can hardly be a doubt that this layer of sand once covered the whole mountain district, so that the gneiss rocks, which had been eroded before the Potsdam sea rose to cover them, were preserved from further erosion until quite recent times. That the limestones over the Potsdam also covered the mountains is equally evident; and there is no reason, therefore, to oppose the suggestion that the whole Palæozoic

system 30,000 feet thick has been removed from off the South Mountains. All this had to be removed before the gneiss rocks could come under erosion again and the present surface be got.

The great extent of the Potsdam sandstone formation throughout the United States is described by Prof. Rogers, (Geol. Penna., 1858, Vol. II, p. 780,) who finds two arguments for the view that it was deposited in a quiet sea. 1. Its fine sandy character, and 2. The perpendicular position of a fossil form, the long, slender, delicate, stem-like *Scolithus linearis*, by the uncommon perfection and abundance of which it is characterized.

The sands of which this formation consisted originally had been (with a few exceptions to be afterwards noted) changed by pressure into a hard, compact, bluish-grey quartzite, which when weathered, as notably along the Neversink hills exposure on the east bank of the Schuylkill, become a dull, dirty brown, due to ferric oxide.

Frequently grains or nodules of feldspar occur in the quartzite, which in weathering give rise to Kaolin, and leave the original rock in a pock-marked condition.

The Hematite (specular) and Limonite ores of iron have been found in the Potsdam white sandstone, the favorite position of the former being apparently immediately underneath the sandstone, while the Limonite is confined to a higher horizon in the formation.

Much more economically important in the light of having furnished, by its decomposition, the best quality and most persistent of the Limonite beds of Berks county, is the fourth or upper member of the Potsdam series, the *newer slate.*

The quiet deposition of the white sandstone must have been succeeded by a still gentler sea, to allow of the formation of the fine silt and mud from which these slates were formed by subsequent pressure.

The period must have been one of great duration to allow of the quiet sedimentation of this considerable body of greenish-blue and brown argillaceous and generally soft and shaly slates.

Like the other members of the formation its greatest development is in the south, thinning perceptibly N. E., and disappearing entirely before reaching the Delaware.

Prof. Rogers refers to its occurrence on the Schuylkill, along the Neversink hills, which seems doubtful, unless it exsists in such a metamorphosed and indurated state as to be no longer recognized as slate; and elsewhere in his report refers the Oley slates to Potsdam age.

It is to be regretted that the excellent sequence of exposure of Potsdam rock south of Reading, in the cuts of the Philadelphia and Reading R. R., are so metamorphosed and contorted as to render it difficult to distinguish cleavage from dip, rendering a section measurement here very unreliable; but I should judge the series to represent a thickness of 300'±, brought up in two main compressed anticlinals referred to in chapter 2, page 39.

Along the north base of the South Mountains, on the Index map accompanying this report, no attempt has been made to color the slate areas existing in places between the sandstone and the Magnesian limestones of the Great Valley, for no such division is possible.

Indeed the point of contact between the sandstone and the gneiss to the south, is rendered everywhere obscure by the immense quantity of boulders that covers the entire north flank of the mountain, concealing even the outcrop of sandstone *in sitû*, though the normal dip of the sandstone is to the north-west, lying unconformably on the overturned south-east dipping gneiss.

The *Oley Valley slates* are generally considered to belong to the Potsdam epoch, though reasons have already been advanced to show that portions of them may belong to a later period—that of the Hudson River (matinal) slates of III.

In the disturbed condition of the country wherein they occur, showing innumerable twists and contortions, structure will not help us out of the difficulty, while the *lithological* resemblance of the slates of Nos. I and III, prevents any conclusion being reached on this evidence.

They are strongly marked with south-east cleavage planes

in obedience to the general Appalachian law, and are considerably developed in this valley.

It is the junction of the Potsdam slates with the limestones that marks the horizon of most of the important limonite mines along the north base of the South Mountains, in the East Penn valley, so that they at once occupy the same economical importance as an iron ore horizon, as the slates of III, whose base or junction with the *top* of the limestones has furnished the location of a second horizon of persistent ore beds, exemplified in the old Moselem and Ironton mines.

Potsdam Sandstone Areas.

Entering from Lehigh county, where it has occupied a narrow strip at the base of the South Mountains all the way from Allentown to Alburtis, the Potsdam sandstone will be found flanking the gneissic hills in an unbroken line of undulating foot-hills as far as Reading, penetrating into the gneiss region south of them through several gaps running back from the limestone valley, and connecting in several places with other deposits of the same formation higher up in the range, notably south of Pricetown in Ruscombmanor township.

Four miles north-east of Reading, and east of Barnhart's tavern, the Potsdam sandstone completely covers the crest and descends on the eastern flank of the long Deer Path or Mount Penn anticlinal, exposing on its summit several good outcrops of massive sandstone, and strewing the flanks of the hill with a sea of small and large boulders. This hill is bereft of vegetation, and presents a conspicuous sight to the traveller along the Schuylkill valley, approaching Reading from either side.

Everywhere from the Lehigh-Berks county line to Reading the sandstone has been greatly metamorphosed into a hard compact quartzite, completely obliterating the marks of its characteristic fossil—the *Scolithus*—except on the north flank of Lock Ridge, where some excellent markings have been reported by Prof. Prime.

The actual covering of sandstone along the north flank of

the mountains can not be very thick, as frequently an apparently extensive tract of it will carry on its surface numerous gneiss boulders belonging to that formation in place at no great distance beneath the surface.

Indeed, in some of the iron mines along these foot hills the gneiss floor has been struck in from thirty to fifty feet of digging, though the Potsdam sandstone formation is considerably thicker at Reading and in the whole of Berks county than further east in Lehigh county, where Prof. Prime assigns a thickness of 25′ to it.

South and east from Reading the Potsdam sandstone occupies a considerable area of country in the townships of Exeter and Alsace, known as the Neversink hills, where it has been greatly altered and weathered and strongly marked with cleavage.

West of the Schuylkill, in the area shown on the Index map, there is a considerable development of No. 1 sandstone and slate, the former appearing in the Wilmington & Northern R. R. cut; in the two hills south and south-west of Shillington, in Cumru township; and in a considerable portion of Spring township.

The slates are most conspicuous in the hill close to the Spring-Cumru line, about one half mile N. E. of the five-mile house, and shown on the map lying at the eastern base of the Potsdam sandstone hill.

The central portion of Longswamp township contains a considerable belt of Potsdam sandstone, entering from Lehigh county at Alburtis and flanking the N. W. portion of Lock Ridge to the Little Lehigh creek south of Shamrock.

Entering the gneiss region through the gap formed by this creek, it spreads east back or south of Lock Ridge as far as W. Rohrbach's house, and west in the cove back of the hornblendic gneiss hill upon which the Tatham mine is located, as far as where the 700′ contour strikes the road leading south from Topton.

In the cove a considerable amount of iron ore has been taken out of the limonite mines designated by the Nos. 48, 49, 50, 51, 52, and 53.

A dip of S. 20° E. 24° is seen on the public road about ½

mile south of Longswamp church, which marks one side of a compressed synclinal trough extending up this cove, rising rapidly to the west.

A few hundred yards S. S. W. of Longswamp church Fritch Bros.' bank of brown hematite is located, which, though now abandoned, has furnished some good ore in the past. Here, also, graphite was found and considerably mined formerly on Smeck's farm.

On Mr. Long's farm, a short distance from Mertztown, exploitation has been carried on for some time in a deposit of Kaolin clay belonging to this formation, and a considerable amount taken out and used in the manufacture of white china.

Several shafts have recently been sunk—one of them 37′ deep, as reported by Mr. Hoch, of Topton—on property of John M. Mohr, at Longswamp church, 1 mile south of Mertztown, for the purpose of mining calomine. In physical attributes the specimens obtained bear some analogy to the Friedensville zinc deposit, and Mr. Job H. Folk, who leased the property, determined to test the truth of the story of 20 years' standing regarding the value of the material. Hand specimens sent me were identical in appearance to the vast variety of drusy quartz, chalcedony, jasper, etc., found at Flint Hill, in Rockland township, and a box of the material sent to Mr. McCreath for analysis by parties interested confirmed its being "drusy quartz colored by ferric oxide."

The territory is entirely within Potsdam sandstone.

A short distance north of the school-house, and on the western flank of Lock Ridge, several exposures of Potsdam *in sitû* occur, dipping from S. 15° E. to S. 25° E. 44°, 57°, and 59°.

Potsdam extends up the Little Lehigh creek as far as the 550′ contour on the east side, where it becomes covered with gneiss boulders.

Another small patch of Potsdam sandstone occupies the valley of the Swope creek from Maple Grove village into Lehigh county, carrying limonite in several places.

A third patch occupies the high ground north of Henig's tavern down as far as the 1050′ contour.

It is not seen anywhere here in place, but occurs as quartzite boulders, many of which strew the road to Longswamp church. This summit is 1150′ above ocean.

Hereford township shows Potsdam quartzite boulders in the neighborhood of St. Peter's church, occupying the high plateau half in Lehigh and half in Berks, about the 900′ contour, accompanied with trap boulders.

Descending the crest of Furnace hill towards Hampton furnace, decomposed sandstone and shale soil cover the valley of the Perkiomen, and Potsdam no doubt exists in place back of the Magnesian limestone quarries there, though no dips were discerned. It comes in about thirty feet back of the quarries. No primal slate is recognized between it and the limestones, which everywhere become more siliceous as they recede from the valley.

Potsdam occupies the summit, and a part of the north flank of hill 800′, and its boulders are found all the way up the valley to Siesholtzville, where in a decomposed condition it is exposed on the Red Lion road north of Moll's tavern, mixed with a green talcose slate.

The next exposure of Potsdam is seen in G. Griesermer's quarry just east of Treichlersville, and on east flank of hill close to the road leading from the Palm-Treichlersville pike north into Lehigh county. The Potsdam is of normal bluish grey color, and has been quarried for building purposes.

There is an exposure here of 100′ ± dipping N. 25° E. 40°, though considerably split up with south-east dipping cleavage joints, which are of great assistance in quarrying it.

Potsdam covers this summit 610′, (which is an off-shoot of the gneiss hill east of the Lehigh line,) and extends up along the Emaus pike and Perkiomen creek to a small branch creek about 1 mile north of Treichlersville and just at the Lehigh line, where it meets a hard micaceous gneiss with distinct laminations, dipping at creek S. 35° E. 29° and at the Lehigh line S. 35° E. 80°.

This outcrop of sandstone is interrupted south of Treichlersville by the No. II limestones spreading out in the val-

ley, but is again seen occupying the outlying ridge from A. Krieble's house down to the Devil's Hole road near the toll-gate towards Clayton.

Two patches of gneissic conglomerate show on the ridge of this hill, which is divided from the new red shale on the east by the narrow limestone valley of No. II and immediately joins the South Mountain gneiss on the west, from which it is divided by a small creek rnnning up from S. Schultz's place.

Near the junction of this gneissic conglomerate and No. 1, south of the T. Schultz estate, there is an old abandoned ore opening belonging to Squire Hile.

No information could be obtained concerning the ore, which, if found at all, was probably red hematite. The dump shows a considerable pile of greenish talcose slate and reddish sandstone, colored by peroxide of iron, but only small pieces of ore.

The general outline of this area of Potsdam will be seen on inspecting the index map.

It continues up branch of Perkiomen creek, along the Huff church road, as sandstone boulders filled with feldspar nodules, occupying a narrow strip between the two large feldspathic gneiss hills, and connects with a large body of sandstone in the S. W. corner of Hereford, south of Black Head hill. A cove running west from D. Oberholtzer's place to the smith-shop on the Perkiomen creek at the head of the Dale Forge valley, marks its northern limit. Its south boundary is the small creek coming up from Schall's dam.

No dips were obtained in it, as its area is everywhere marked with a profusion of sharp and angular boulders, of all sizes, completely hiding its outcrops.

These boulders are composed of a hard white compact quartzites, surrounding the Dale Forge valley on three sides. On the west side it occupies the outlying ridge up as high as the 700′ contour.

A strip of gneiss 2,000 feet wide divides the Dale Forge sandstone from its continuation into District township,

where it is found occupying a small patch of territory east of Landis' store.

It is of the same character as at Dale Forge, and occupies the crest and west flank of small hill north of the Landis store—Dale Forge road down to the branch of the Perkiomen creek, which takes its rise here.

Proceeding west over a belt of gneiss 3,000 feet wide, Potsdam is next met with west of the Landis store—Hill church road, mixed with gneissic conglomerate, lightly covering the hillside below the 900′ contour to a depth of about four feet, under which the gneiss floor is seen. This is the extremity of the great body of sandstone coming up the valley of the Manatawny, and is very thin and irregular here.

D. Hoffman has put down several ore shafts on this hill to a depth of sixty feet, all of which after passing through four or five feet of sandstone and gneissic conglomerate, meet a decomposed micaceous gneiss.

The ore is magnetic, but very little of it is seen as a result of the shafting.

Another patch of sandstone in District township lies south of the Perkiomen creek, and extends over the hill from A. Benfield's place to the house of P. Smith. This is close to the District-Longswamp line, and contains the Meck farm, which has been successfully tested for iron ore though as yet undeveloped.

Returning to the Manatawny creek deposit, Potsdam sandstone flanks both sides of creek from the District-Pike line south-west to Pikeville, where it divides into two branches to surround the Oley valley limestones.

On the north side of the creek, north of Reider's mill, where it rises to the 500′ contour, it can be traced flanking the gneiss hill on the south, and generally south of the Pikeville road to the school-house, one mile N. E. of Pikeville, where it swings north around the prominent and well-defined gneiss hill to join the Pine creek and Lobachsville deposit.

On the south side of the Manatawny it rises much higher

on the north leg of the Rolling Stone hill anticlinal, completely covering the hill up to the 900′ contour.

It is finally exposed on Rolling Stone hill about the 860′ contour, slanting first for 200′ at about 45°, and then pitching suddenly for 130′ more on a 75° dip.

The dip is about N. 40° W. 50°-70°, and owing to the amusement afforded by rolling stones down this steep incline, the hill has taken its name.

The ledge is composed of about 40′ of hard, white quartzite, worn smooth and bare from constant abrasion with boulders thrown down its surface, and but for the woods that thickly cover the hill, would be a prominent landmark.

About 200′ south and near the crest, gneiss comes in dipping N. 25° W. 42°, and forming a portion of the north leg of the Rolling Stone hill arch.

Further south-west at bend of wood road leading down to the valley, and immediately back of G. Conrad's house, the south limit of the anticlinal is marked by a Potsdam sandstone dip of S. 10° W. 70°, duplicated about 500 yards south on main road by a gneiss dip of S. 20° E. 20°, which latter marks the divide between gneiss and Potsdam.

The southern limit of the latter extends west from this point, running down cove through which the public road is laid to within 800′ of the valley, where it turns to the south-east towards Hill church.

Crossing the Hill church road at S. Brumbach's house, this strip of No. 1, about 400′ on each side of the creek, continues up between the forks of stream at Brumbach's, and occupies the whole of the summit 1030′ to the Earl-Pike line.

The ridge of this latter hill is composed of the siliceous gneissic conglomerate, which generally marks the thinning of the Potsdam, and its sides and the neighboring roads are packed with sharp quartzite boulders, derived from its decomposition in the hill.

A dip of S. 53° E. 50° was obtained at a small ledge of rock on the south-west flank, but the outcrop was too small to make this reliable.

Further down near the forks of the creek it has been

quarried to some slight extent, evidently under the impression that it was limestone, but no good dip could be obtained here.

Further down creek towards Pikeville, and just on roadside at old school-house, there are two exposures of broken sandstone, the first of which dips S. 25° E. 45°, and the second S. 30° E. 50°. Both outcrops are small.

From Pikeville the main body of Potsdam SS. swings south-west along the east bank of the Manatawny creek as far as Spangsville, in Oley, where it recedes towards the hills and gives place to a narrow belt of No. II, coming up from Earlville and occupying both sides of the creek thus far.

The sandstone is splendidly developed in Earl, always occupying the north-west flanks of that series of closely-folded anticlinals and synclinals spoken of in Chap. II, and occasionally riding over the summits of some of the bold and rugged hills.

It can always be traced a considerable distance up the numerous streams that come down from those hills, even though the hills on both sides are gneiss nearly to the water's edge.

Beginning on the north, a dip of S. 40° E. 40° is obtained on back road near D. Bertolet's house, where some little quarrying has been done in the rock.

It is here impure and shaly.

The crests and south flanks of the hill to the east of this point are gneiss, but the Potsdam is steadily rising until on Saw Mill hill, in Earl township, the crest of the hill is its south limit.

The back-bone of this ridge forming the Shenkel Hill anticlinal is composed of gneissic conglomerate, dipping at the Dotterer mine, on Saw Mill hill, S. 45° E. 80°. Overlying this conglomeratic rock and dipping conformably with it in the Dotterer mine, there occurs a reddish argillaceous slate carrying red hematite ore.

This has been proved over 40 feet thick and may be a representative of the Potsdam (primal) older slate.

The Potsdam SS. crosses the Shanesville road about a mile

east of the Manatawny, apparently dipping at the forks of the road, near school-house, almost due north 70°.

Rising up on Shenkel's hill it curves to the north of Pinnacle Point, which is gneiss, but soon resumes its place on the back of the hill to the Furnace creek, near J. Drumheller's, where the anticlinal dies under the Oley Valley.

At the forks of the road here there is a dip of quartzite N. 40° E. 60°, but there is doubt whether the large mass of rock there is really in place.

On opposite side of road it outcrops in small knoll dipping S. 80° W. 48°–50°. It has been quarried here and is about 35 feet thick, though, as exposed, of rather inferior quality of stone.

Potsdam SS. extends back along Furnace creek for some distance, rising on the north to only about 50 feet on the flank of the gneiss hill, but to the south spreading completely over the crests of Furnace hill, Owl Head, Saenger's hill, and Stone Cave hill to the Powder Mill valley, covering this area with a vast amount of boulders of all sizes and creating a dry and barren wilderness.

Its general position only can be noted as occupying the crests and north-west flanks of these hills, and the detailed location must be obtained from the Index map.

Furnace Hill near the creek shows dips of N. 5–15° E. 33° with marked cleavage planes, and a little further south in bluff about 50 feet above creek, a dip of S. 10° W. 70°.

Further along road towards D. Herring's place, a Potsdam prong comes in from the north-east, showing a ridge of sandstone running up hill from creek, with dips of N. 45° W. 45° to 62°, outcropping in numerous places up hill and occasionally appearing to stand vertical.

The whole spot is a very wild and picturesque one, the broken quartzite boulders from the steep hill sides almost choking up the narrow valley.

Kaufman and Spang's old specular ore mine is situated in Furnace Hill, an old tunnel leading in from the road to the workings that had been carried down from the top of the small hill. Magnesite was found in it.

Potsdam occurs again in place on outlying ridge between

the ore holes and the road, dipping S. 70° E. 50° and S. 45° E. 75°, forming a prominent ridge of rock which ends in the bluff mentioned above.

The sandstone is fully 60 feet thick here, though difficult to measure on account of the numerous cleavage joints.

The crest of Furnace Hill at summit 920′ shows Potsdam dipping S. 65° E. 70°, a hard, compact, white quartzite ledge 35′ thick.

Further S. W. along ridge, at contour 840′ the outcrop is perpendicular and exposes about 20 feet of rock, which 200 feet further on shows a dip of N. 70° W. 50° and marks the north limb of the anticlinal.

Between it and the Saenger's Hill ridge on the S. E. there is a small nose of Potsdam sandstone, showing dips S. 45° E. 70° and S. 47° E. 80°. This outcropping ledge ascends in an almost perpendicular ledge 60 or 70 feet high and 15 feet thick, composed of massive quartzite beds devoid of cleavage.

Owl Head Hill, 1000 feet to the S. E., is a N. E. prolongation of Saenger's Hill, and exhibits a well defined anticlinal of Potsdam sandstone dipping S. 62° E. 54° where the hill descends sharply towards T. Geiger's house, and N. 56° W. 65°, about 400 feet further south-west along crest.

Saenger's Hill shows dips on its summit of S. 35° E. 60° and 300 feet south-east S. 32° E. 62°.

Further down the south side, the anticlinal axis is well marked by two opposing dips N. 80° W. and S. 30° E. 60°, the anticlinal quickly dying away afterwards in the limestones along the Manatawny.

Stone Cave Hill, the next proceeding *en echelon* south-east, is a short but prominent axis, very tightly pressed and showing evidences of its closely folded character in the "Stone Cave" on the Earlville road. Cleavage abounds throughout this hill and is well displayed on the road, dipping almost due south 80°. The Potsdam itself dips on the road N. 68° W. 35 and S. 70° E. 52° at the point where the anticlinal is cut through by the Manatawny. A little to the south of this, along road, there is an outcrop of alternate

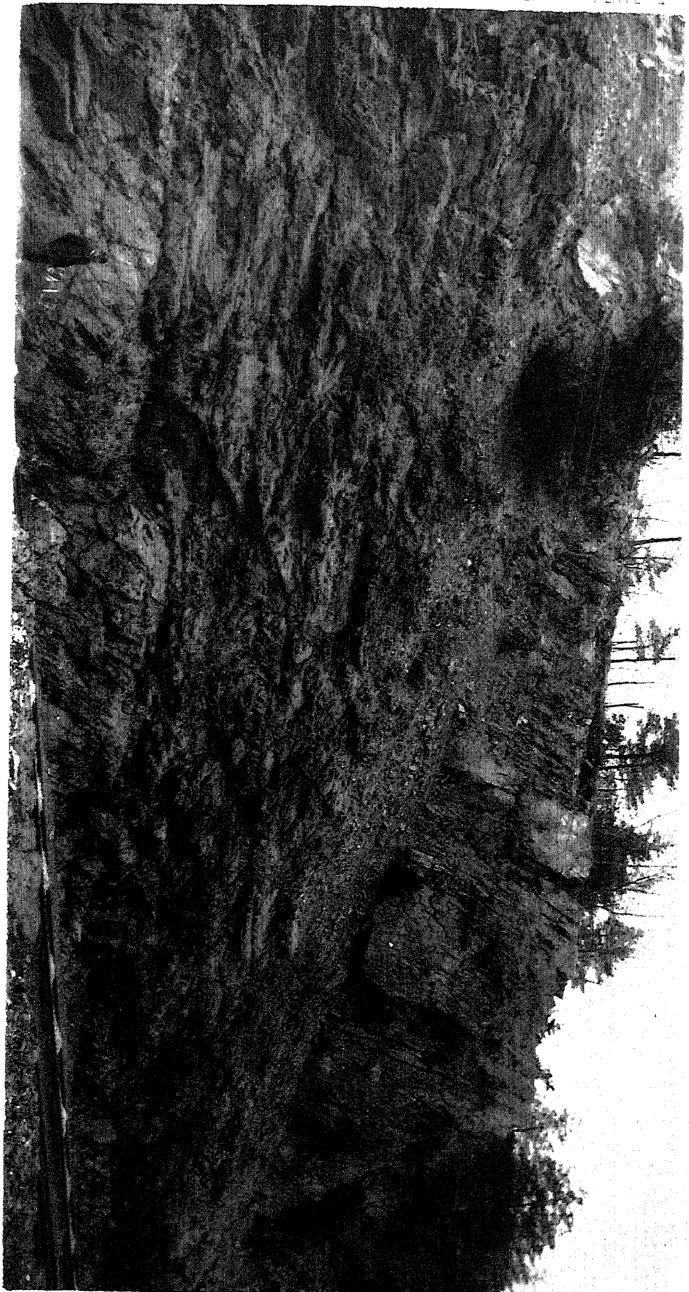

FIG. 6. POTSDAM SANDSTONE OF NEVERSINK HILLS, EXPOSED IN THE RAILWAY CUT, AT THE LOVERS' LEAP, 3. MILES SOUTH OF READING, BERKS COUNTY, PA.-- LOOKING S. 45 E. (PICTURE REVERSED.)

layers of quartzite and indurated shale or slate, all greatly confused by cleavage, but probably dipping N. 70° W. 30°, whilst still further south, probably 200 feet, hard, compact quartzite dips S. 38° E. 65°–85°.

Rising on the anticlinal from the "Stone Cave," the Potsdam outcrops look like huge pulpit rocks, rising 60 feet into the air and extending up the hill with a general south-east dip of S. 60° E. 55° to 80°.

If I have distinguished dip from cleavage correctly here the exposure must be at least 100 feet thick.

This anticlinal brings the Potsdam sandstone up on west side of Manatawny creek in Rabbit hill.

Close to the creek there is an outcrop 40 feet wide, dipping N. 30° W. 55°, whilst on the summit there is an exposure of compact sandstone almost all quartz, of a yellow color, dipping S. 62° E. 75°, and forming a conspicuous ridge.

The Long hill anticlinal carries a large amount of Potsdam on its crests and sides, beginning on small creek south or J. Wolfgang's house in Earl township, and extending S. W. to the Manatawny.

Summit 1070′, south of C. Kuser's house, shows outcropping sandstone on its crest dipping S. 27° E. 56°, with a terrace of gneiss on its south flank divided from the Potsdam ridge by a narrow cove.

Further west, 3000 feet along summit, the sandstone dips N. 40° W. 65°, in an outcrop 10 feet thick of hard quartzite, and on the decline of the hill towards the public road, above the 1000′ contour, the anticlinal is well marked by two dips of S. 55° E. 80° and N. 50° W. 85°.

West of the road a small area of gneiss flanks the south side of the first knoll, which rising quickly from the road shows dips of sandstone and milky quartz on its crest of S. 38° E. 48° and S. 32° E. 65°.

Further west, 250 yards, sandstone again outcrops in a ledge 12 feet thick, dipping S. 65 E. 60°, the position of the anticlinal being again plainly marked, 200 feet west, by dips of sandstone S. 65° E. 55° and N. 65° W. 76. This whole 200 feet is practically one outcrop of sandstone, un-

covered for 30 feet along its line of dip, and forming therefore a prominent ledge.

After passing a small cove in the hill a double crest of Potsdam rises, showing dips on its north half of S. 45° E. 60°, S. 60° E. 70°, and S. 42° E. 36°, presenting a fine ledge of close-grained white sandstone, of firm and compact texture.

Just as the hill begins to sink in the Powder Mill Valley, 400 feet further west, a last dip of S. 42° E. 65° was obtained. The exposures along this anticlinal of Mengle's hill are among the finest in the township.

Naugle's hill, 300 yards south-east of last exposure, and on the south side of the public road skirting Mengle's hill, shows further exposures of Potsdam sandstone and quartzite, beginning on the east and in the summit 770′, with S. 12° E. 40°, where numerous sandholes have been dug to obtain building stone. The hill is an isolated one, showing a wide plateau on its summit gradually rising to the N. W. into Mengle's hill, but declining almost perpendicularly for 300 feet on its south and south-west sides into the Powder Mill Valley.

On its S. W. side, which marks a rapidly dying anticlinal, another exposure of sandstone dips above the 650′ contour S. 50° E. 70°.

Powder Mill valley, inclosed between this rugged precipice and the almost equally formidable Fancy hill on the south, is a dreary and desolate spot, rarely lighted by the sun's rays and almost totally uninhabited.

About 300 yards up stream from Widow Giles' house, and on the south side of road, sandstone dips towards Fancy hill S. 50° E. 75°.

Further N. E. up stream 800 feet, at the old Powder Mill falls and just at bend of road, there is a prominent ledge of quartzite dipping into Fancy hill S. 75° E. 74°, and on opposite side of creek, into Naugle's hill, N. 52° W. 62°.

From this latter point up to public road rising over hill there are continued exposures in Naugle's hill, from 30 to 40 feet thick, showing dips of N. 55° W. 68°, N. 50° W. 60°,

and N. 45° W. 60°, and above Falls 100 feet on south side of road N. 60° W. 68°.

The whole valley exhibits many exposures, worn bare by the rushing waters of Trout run, of which the above are fair averages.

North-east of hill road about 200 yards a small knoll of Potsdam juts out between the Boyertown road and the creek, in which Potsdam SS. dips N. 72° W. 65°, and in which cleavage is strongly marked.

This little knoll belongs really to Fancy hill, which, lying south of Boyertown road, is divided from Long hill by a narrow wedge of hornblendic syenite, starting from the forks of Trout run, west of J. Swavely's house, runs north-east in a narrow belt to join the main body of gneiss in Colebrookdale township.

The most prominent point of Fancy hill on the east is the Devil's Hump, a round summit of Potsdam sandstone rising from near the Colebrookdale-Earl line to a height of about 1000 feet above ocean level, and a conspicuous feature to an observer travelling up the Ironstone creek from Gabelsville.

Proceeding west or south-west along the Fancy hill ridge and leaving the rugged and boulder-covered Devil's Hump, sandstone is met with *in sitû* on the next rise about contour 1050′, dipping N. 50° W. 80°.

This is the only outcrop obtained along the entire length of this hill from the Colebrookdale line to Earlville, where the anticlinal dies down beneath the limestones of No. II. The crest of this hill is about 80 feet wide, its highest point being about 1080 feet above ocean level.

Its sides are covered with boulders of all sizes and description and form a forest of chestnut trees of short and stunted growth. Its crest, however, is well cleared from underbrush, and of sufficient regularity and smoothness to admit of a good wood road here.

It was a famous hunting-ground for game of all description in the past, and many a fox has met his doom upon its sides.

It is flanked on the south with gneiss, extending through a cove, and dividing it from Sand hill to the south-east.

Near Earlville, however, the sinking anticlinal permits the Potsdam SS. to swing around its eastern base, occupying a belt of increasing width north-east to the Colebrookdale-Douglass line, which sharply divides it from the gneiss.

The *Sand Hill* area of Potsdam is but a wing of this, which leaving the main body north of G. Focht's house, spreads in a thin belt N. E. over the crest and west flank of Sand Hill as far as the Ironstone creek, in Colebrookdale.

It is quarried on the north-east decline of this hill, where it dips N. 60° E. 70° and displays a vitreous sand rock of remarkable purity and whiteness, which has given the name to the hill.

Other exposures of sandstone are seen on summit 460′ up from the Boyertown road N. W. of Davidheiser's limestone quarry, where it dips S. 54° E. 85°, and further north up hill at cross roads S. 45° E. 76°, where it is slightly quarried for road ballast.

Again at the base of Fancy Hill, in Earl township, and north of R. Hartranft's house, the dip is almost due west 45°, where the sandstone is greatly decomposed and weathered. Nearer Earlville still and close to the north side of the Reading road, it is opened in J. Rhoad's sandstone quarry. The quality of the stone is poor here and greatly broken up with cleavage joints and stained brown. The dip was apparently S. 60° E. 52°, but was rendered doubtful by the steeply S. E. dipping cleavage joints.

The remaining areas of Potsdam SS. in the eastern part of the county are confined to the township of Colebrookdale and Washington, and the intermittent character of the deposit is well shown on inspecting the map From Boyertown to Bechtelsville it occupies its proper geological position between the gneiss and limestone, though very irregular in its occurrence, sometimes occupying only a narrow belt of low land, and again crowning the summits of some of the rounded gneiss hills so conspicuous in this part of the county.

At Boyertown it has been considerably worked in the small hill to the north of the borough, in Stauffer's quarries, which displays a stone filled with feldspar and quartz grains, whose decomposition has given rise to considerable deposits of Kaolin clay in the cellars of the houses at the foot of the hill.

The stone is not compact, and the ready decomposition of the feldspar causes it to quickly decrepitate into a sandy mass. It has however been considerably used for street ballast and the porous nature of its sandy decomposition allows of a thorough surface drainage of the streets, and so presents a neat appearance wherever used.

These quarries are worked and owned by P. Stauffer.

In the western quarry, the sandstone dips S. 6° E. 40°, and in the east and larger quarry, the dips are all to the north-west as follow: N. 35° W. 50°; N. 20° W. 70° and N. 15° W. 42°. The hill shows a small anticlinal roll.

This rock may have some representation in the Phœnix upper slope, located near its junction with No. II.

The sandstone is nowhere exposed between Boyertown and Bechtelsville, and its general outlines will be noticed on the index map.

The small ridge west of Sassaman's smith-shop is covered with flint chippings and shows a little gneissic conglomerate on its crest.

Another patch of sandstone occupies the rounded hill back of Oberholtzer's limestone quarry about one fourth of a mile north of Bechtelsville, and extends to Eshbachville, though some of the boulders on this hill look like crystalline limestone, and effervesce when touched with acid. One such, in the museum of the survey, picked up loose on this hill, has imbedded in it a large mass of crystallized dark green pyroxene and a mass of red garnets, whilst the whole mass of the boulder is specked with small hornblende crystals.

Another patch of sandstone has been left covering all the country from the west branch of the Perkiomen creek, north of Barto, to the bend of the Swamp road at the old school-house near H. Diehl's house,—joining the new red

shale on the south and flanking the South Mountains up to about the 700′ contour.

It shows one outcrop on road about one half mile up hill from Churchville of N. 10° W. 48°.

It completely cuts out the limestone in the vicinity of Churchville, and is divided from the Mesozoic red shale pretty nearly by the small creek courses south of Churchville.

Returning once more to Pikeville, the Manatawny deposit swings north over the dying double gneiss anticlinal and turns north-east up the valley of the Pine creek as far as T. Geisler's house.

On the hill south-east of Lobachsville the sandstone becomes very coarse in texture and of a purplish color, and some excellent building stone slabs have been taken out of quarry on G. Keim's place, above contour 650′, where the rock dips S. 20° E. 50°.

The road from Pikeville to Lobachsville is covered with boulders of this conglomeritic sandstone, though it passes over a narrow patch of gneiss dipping S. 55° E. 70° just at nose of hill near St. Paul's church.

West of this church, there is an exposure of gneissic conglomerate capping the hill, which, on its southern decline, dips almost due south 70°.

This hill on its western flanks is covered with small ore pits, though no ore is visible on the ground.

The sandstone extends down the valley to the 350′ contour and extends west to small creek running out from B. Yoder's springs in Oley township.

There are two limestone areas in this sandstone that will be mentioned in chapter 5.

One of them, containing J. Keim's quarries, immediately joins the gneiss on the north, but otherwise the sandstone everywhere flanks the azoic hills up to about the 450′ contour.

At Yoder's place the sandstone area thins out greatly, occupying a narrow strip between the creek and the Laurentian gneiss.

South of the creek there is about an equal amount of limestone, south of which occurs a slate hill.

From Glase's mill on the north, S. E. to Bertolet's mill, there is another patch of slate, probably Potsdam (upper primal) occupying hill two and a half miles long north of the Friedensburg-Spangsville road, and between these two slate areas Potsdam sandstone boulders, very quartzose, spread over all the flat country between Furnace creek and the first-mentioned hill, down to the junction of No. II limestone at contour 360′.

Another patch of surface sandstone occupies all the country between the Monocacy creek and the Friedensburg-Reading road, from J. Knabb's place on the south up to the Friedensburg-Spangsville road.

It swings east to Bertolet's mill between the road and the Little Manatawny, and north-west up the Little Manatawny past Kaufman's mill, between the gneiss and slate, narrowing greatly towards Glase's mill. Over all this flat country no outcrop is seen, the Potsdam sandstone boulders, mixed with slate detritus, being the only guides to the limit of the formation.

At Glase's mill it joins a wider range of Potsdam, which extending west through the southern part of Ruscombmanor township, occupies all the high ground in northern Alsace, ending in the East Penn Valley east of Barnhart's tavern.

In southern Ruscombmanor it is confined to the narrow hill between the two branches of the Little Manatawny. west to the Pricetown road.

The flat country near the forks of the creek is strewn with boulders of coarse, purplish, Potsdam quartzite, stripped off the Potsdam ridge to the north in Furnace hill; but soon the normal, bluish-white, arenaceous sandstone is met with, dipping on the road three fourth miles west of J. Link's house, N. 50°. W. 35°.

The crest of the hill has been tested for iron ore, and a small shaft was put down on W. Shain's place by Eberhard & Eline in 1879, with some little show of limonite.

The place was soon abandoned, however, and does not seem to have been very productive.

Crossing the Pricetown road the Potsdam sandstone

covers a strip of country about one mile wide, from Laurel creek on the north to the Pricetown-Reading road on the south, everywhere a compact white and bluish quartzite.

Near Koch's old tavern on the latter road a wedge of gneiss comes in to divide it from the Deer Path-Mount Penn anticlinal, which takes its rise here; but the belt soon assumes its average width, until it ends in the prominent knob north of Barnhart's dam. It here throws off a narrow arm to the north, which swings around the gneiss hill south of Laurel creek, and passes in a thin strip up that stream to the upper dam of the Clymer Company's Mt. Laurel furnace.

Passing between the limestones of the Great Valley and the gneiss of the Irish mountains, in a greatly attenuated condition, it begins to widen and encroach on the north flanks of the hills skirting the East Penn R. R.

Passing up a branch of Willow creek, south of Blandon, its junction with gneiss is well marked about 400 feet south of Buchert's mill in a ridge of purple conglomeritic sandstone, strongly accenting the topography of the country to the east.

Between Blandon and Fleetwood the Potsdam belt is about a mile wide, its north boundary being the E. P. RR., and extending south to a line drawn due east from the ledge south of Buchert's mill.

South of Fleetwood a wedge of gneiss comes down to within a half a mile of the railroad, and occupies a position between the forks of Willow creek; but immediately east of this the Potsdam, following up the pass made by the Willow creek, ascends high up the hills and joins a range of similar stone to the south, to be presently described.

In this part of the range the Potsdam S. S. is frequently iron bearing, and several productive limonite banks have been opened in it.

From Fleetwood to the Little Lehigh creek at Mertztown this, the most northern range of Potsdam S. S., everywhere flanks the South Mountains on the north in a belt about 2000 feet wide, and covering about 200 feet of the base of the mountains.

Its position is everywhere hidden by an immense profusion of boulders, completely obscuring its lines of outcrops and covering all dips. The upper slates also have a considerable development along the edge of the valley, but are likewise effectually covered up, their presence being only perceptible by the decomposed mass of clay and slate visible in many of the mines.

It has, however, been observed in some of the numerous limonite mines opened in it, frequently to dip S. E. *apparently* under the gneiss, owing to its having been overturned by the same forces influencing the dips in the mountain areas.

About 1 mile south of Bower's Station, on the E. P. RR., is Flint hill, in Rockland township, a mass of Potsdam sandstone, but showing a profuse covering of variegated quartz, chalcedony, jasper, agate, hornstone, with some ochre, limonite, and ferruginous quartz. Molybdenite has also been found here. Many of the quartz specimens show beautiful crystallizations and variegated colors, and especially in the chalcedonic varieties, are capable of a high degree of polish.

South of Lyon's Station, on the E. P. RR., the southern margin of the sandstone is well marked by the meeting of Richmond, Manatawny, and Rockland townships; between this and a more southern range of sandstone there is a gneiss belt nearly a mile wide.

Potsdam sandstone boulders first appear at Stony Point—New Jerusalem road at J. Dry's house, and soon spread south and west over the whole of the New Jerusalem plateau as far west as Souder's mill dam, on the border of Ruscombmanor township.

The boulders here are all composed of a yellow-colored quartzite, often ferruginous, and very good limonite has been mined at Heist's and Bieber's mines.

A small tract of gneiss divides this deposit from that commencing in Green hill, Rockland township, and extending west into Ruscombmanor.

Just south of Keller's mill, on the road to Green Hill tavern, the Potsdam sandstone boulders cover the road,

though gneiss probably is in place here, as two dips were obtained near creek of S. 12° E. 50° and S. 20° E. 55°.

Green hill is one mass of angular quartzite boulders so thick as almost to defy "picking," though its eastern slope is slightly cultivated.

Crossing the creek, the Potsdam S. S. spreads out to the north over the entire hill, as far as the stream running down along the Pricetown road. It contracts near the school-house, where it joins the more northern range. This hill has furnished both limonite and red hematite as will be noticed in the chapter on the iron ores.

West from W. Keller's house, the Potsdam is confined to a belt about five hundred yards wide, having the crests of Sheep hill and Furnace hill for its south margin and the branches of Furnace creek for its north limit, to a point about three hundred feet west of the Udrée limonite mine.

Furnace Creek cuts through the ridge just north of the Oley furnace, and the junction of sandstone and gneiss is well shown on the road there by a splendid exposure of coarse, purple Potsdam sandstone dipping N. 14° W. 40° to 62°—the latter dip predominating.

The outcrop forms a reef of rocks extending far up into Sheep hill from fifty to sixty feet thick.

The sandstone here is very hard and compact and has been named the "Water Stone" by the people in the neighborhood. It probably lies unconformably on the Laurentian rocks of Sheep hill, which dip to the south, and are composed mostly of a dark hornblendic syenite.

Furnace hill on the west, exposes a series of fine outcrops of a coarse purplish sandstone lying always *unconformably* on the upturned south dipping syenitic gneiss, and dipping itself to the north. The first outcrop on the east shows a quartzose purple sandstone, conglomeritic, dipping on summit of hill up from the creek N. 28° W. 54° and three hundred feet further west N. 24° W. 36°.

The whole east flank of the hill is covered with boulders derived from the outcrop along the crest, many of which if dressed would make handsome building stones. The next outcrop of Potsdam is about 1000 feet west along

crest, where it is also coarse and quartzose and dips at several outcrops N. 12° W. 35°.

Two hundred yards west from here and close to the Ruscombmanor line the dip is N. 15° E. 50°.

The outcrop here forms huge pulpit rocks, many of them nothing but boulders nicely balanced on the crest of the hill, while others, owing to their great hardness, have resisted the weathering of past ages, and protrude from the hill crest as prominent landmarks.

Six hundred feet further west the first evidence of this hill being an anticlinal with the Potsdam swept off its lower side, rather than a monoclinal with No. 1 lying *unconformably* on the upturned gneiss, was obtained in an outcrop ledge of white sandstone 20 feet thick dipping S. 4° E. 60°.

The next opening is about 2500 west, feet, in Ruscombmanor township, where a trench has been dug in the purple conglomeritic sandstone here showing a dip of N. 20° E. 35°.

The sandstone exposed is about 15′ thick and should make an excellent quality of building stone.

To the west of this about 400 feet, a sand pit has been dug, from which the finest white and yellow sand is quarried for use at the furnaces of the Clymer Iron Company. The sand is underlaid with a bed of Kaolin clay about 3 or 4 feet thick. West of the public road white sandstone boulders cover the hillside down to the creek, sandstone being only once exposed in place, at the Udrée bank, dipping N. 15° E. 70°.

The next important sandstone area is that occupied by the Deer Path-Laurel Creek-Mt. Penn anticlinal, extending from the Pricetown road at Koch's tavern on the north, south-west for over 3 miles to Reading, showing everywhere along its crest and flanks evidences of the white No. 1 Potsdam sandstone. The belt is nearly a mile wide, extending from the margin of the No. II. limestone on the west to the gneiss hills of the South Mountains on the east. This majestic hill is practically one straight line for 3½ miles, striking N. 40° E. and S. 40° W., rising at the "Black Spot" to a

height of 1146′ above ocean level at Raritan Bay, and having a general elevation along its length of 1000 feet.

Anywhere from its summit magnificent views can be had of the East Penn-Lebanon Valley, and the valley of the Schuylkill far up towards Port Clinton. No finer scene can be imagined on a clear day, and its rugged, uncultivated crest, piled up with huge masses of sharp sandstone boulders, presents a striking contrast to the busy, peaceful scene below in the valleys.

Deer Path hill shows no exposures, and is much wilder and rougher than Mount Penn.

The latter hill really begins at McKnight's Gap, at the subsidence of the Laurel creek hill, and along its crest towards Reading several good exposures of sandstone were seen which mark the presence of an anticlinal along its crest.

The first of these on the north is S. 42° E. 35°, and after passing the U. S. Signal Post at the "Black Spot" two dips were obtained just where the hill begins to sink into the first cove.

These showed N. 50° W. 25° and S. 54° E. 60°.

On next succeeding summit 980′, the white quartzite dips N. 74° W. 35°; 800 feet south from this point is the "White Spot," so called from a vast collection of boulders of Potsdam white quartzite in a bare and treeless spot, which is conspicuously seen when approaching Reading along the railroad. The place is by no means picturesque itself, but, owing to the open nature of the surroundings, a magnificent view may be had here.

Further down the hill, near the fair ground, Potsdam S. S. has been quarried in some gravel pits, the hill being cut down in a perpendicular face fifty feet high, to furnish ballast. The immense hole is a great disfigurement to the town.

The Laurentian rocks which lie east of Mount Penn swing around its southern end in a belt about three hundred yards wide, and near its junction with the Potsdam, some old ore pits are seen which have in former times yielded a consid-

erable amount of magnetic iron ore. Both Potsdam and gneiss die down under the limestones of No. II in the town.

The next noticeable exposure of No. I is in the *Neversink hills*, south of Reading, which form the conspicuous high land seen in approaching Reading from the south, and rival Mount Penn in height and scenery outlook.*

The cuts of the Philadelphia and Reading railroad from Reading south to Neversink station exhibit a fine section of these Potsdam rocks, but, owing to the excessive cleavage, one very difficult to measure with any satisfaction. Difficulties of this nature are well shown in the photograph Plate 2, Fig. 6, taken at the first signal tower below Reading and just south of the Lover's Leap, where excessive cleavage in the rocks displays an apparent non-conformability in the Potsdam itself, the dip at the top and bottom of the cut being steep to the south-east, while a band of enclosed strata thirty feet thick shows an apparent north-west dip of about 30°.

The Potsdam here is a hard ferruginous quartzite, showing an overturned anticlinal of compound flexure, the steep limb of the arch being towards the north-west in obedience to the more prevailing rule.

The line of this anticlinal is marked by a long reef of rocks extending far up into the hill, well exposed on the White House road at the bend, dipping S. 40° E. 65° and S. 30° E. 70°, and on the railroad 200 feet north of the signal tower S. 45° E. 75°–80°. The south limb of the arch is exposed just at signal tower, where the hill recedes into a synclinal cove to admit of the deposition of No. II limestone. The dip of the quartzite is here S. 45° E. 50°.

A little roll takes place just south of the "Lover's Leap," but with steep S. E. cleavage yet, and 200 feet north the dip is again S. 30° E. 60°.

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*From its summit a particularly fine view can be had of the town at its base, alive with its many industries, while a striking contrast of quiet and picturesque life can be had in looking west and south along the undulating red sandstone country, where red soil and bold trap hills immediately arrest the eye. The twisting and sinuous river can be seen for many miles, and with a little clearing of woodland on top the scene from Neversink hills would be unsurpassed.

North 150 feet from this point a steep overturn of grey quartzite shows a dip of S. 20° E. 70°, and further north at P. & R. Co.'s reservoir the dip is S. 30° E. 70° to 75°.

From here to the small creek running down from the hill, still going north, the sandstone is very much broken. Rogers here places a stretch of slightly rolling upper primal slates, with steep S. E. cleavage up to the junction of the limestones.

He calls them "undulated and crushed sandy ferruginous slates, highly indurated," but if they are slates at all they are so metamorphosed and altered as to be practically sandstone, and no such distinction of strata as between sandstone and slate seemed possible to me.

Passing the creek on the north, still another outcrop of this altered rock occurs jutting out of hill side, before reaching the limestones, and dipping S. 45° E. 75°, and about 200 feet south of the Reading Iron Works.

No. II Magnesian limestone is likewise overturned here, dipping just below South street S. 39° E. 80°, *apparently* under the Potsdam. This outcrop is just opposite the Reading Iron Works, and shows a compact white limestone free from cleavage.

All this splendid exposure of Potsdam from its north limit at the Reading Iron Works to the first signal tower is greatly stained and weathered, and everywhere presents a hard yellowish brown and grey quartzite, highly altered and split up by cleavage.

Taking up the section south of the signal tower, where the small creek marks the divide between Nos. I and II, the railroad curves east north-east through a 20-foot cut of undulating No. II limestone, highly metamorphosed and contorted, of a general white or grey-white color, whose first dip at the north end of cut seems to be a south-east one, lying conformably on the Potsdam SS.

No reliable dips could be obtained here, but there seems to be two pretty well-defined rolls in the cut. The dip of the limestone is everywhere slight, and marks the basin of a steeply-rising synclinal cove extending up into the hills.

The south limb of this synclinal is shown in Plate 3, Fig.

7, view taken about 500 yards north of the lower margin of limestone at the Big Dam and about 3½ miles south of Reading.

The Potsdam SS. here has a dip of N. 45° W. 30°–50°, and occurs in layers from a few inches to a foot and a half thick, broken as usual by S. E. cleavage planes, but presenting a bold face of rock extending for 100 feet on the dip up into the hillside.

The old *Neversink quarries* were formerly located here, from which a great deal of stone was taken out for railroad and road ballast. The exposure is a beautiful one, and here again Rogers locates his Primal slate in a highly indurated condition.

The rock is identical with that along the north face of the hill, and only differs from the more massive variety on the anticlinals in the broken and split character of its beds.

The north limit of this synclinal is marked by a dip of S. 15° E. 35°, just opposite Poplar Neck point and on the Philadelphia and Reading railroad track at the north-east end of tangent.

There is an insignificant roll in the Potsdam measures immediately south of the synclinal, which first throws the measures into a south-east dip of 40° and a north-west one of 50°, speedily followed by second main anticlinal of the range close to the Big Dam limestone quarries, which brings up a more massive and compact variety of sandstone in a compound arch, the north limb being nearly vertical and the south leg dipping S. 15° E. 40° to 60°, immediately followed by No. II limestone filled with Mesozoic conglomerate breccia, (See Fig. 8, page —,) dipping conformably with the sandstone at the steeper angle.

The limestone belt cannot be over forty feet wide here, overlaid on the south by Mesozoic conglomerate dipping N. 10° E. 60°.

Close to the edge of the latter the limestone likewise has a steep north-east dip, which is probably only local, due to a split in the limestone, into which conglomerate has been indiscriminately piled.

This feature must have been very much more apparent

some years ago, before the limestone here had been much quarried, and a cut of its appearance during the progress of the First Survey is shown on page —, Fig. 8. Fine crystals of calcite, variety dog-tooth spar, have been found in this old quarry.

The conglomerate here is so calcareous as to have been formerly burned, together with the limestone in the old kilns on the railroad.

Further outcrops of sandstone were seen along the tow path of the Schuylkill canal south of Reading, referable to the first anticlinal range.

The first exposure is about one hundred feet south of the Philadelphia and Reading Railroad Company's pump-house dipping S. 25° E. 48° showing thirty feet of quartzite.

Many exposures are obscured and hidden here by the covering of boulders derived from the hill above, rendering it difficult to record any reliable observations.

Three hundred yards further south, Potsdam outcrops again near the water's edge, mostly vertical but possibly dipping N. 50° W. 88°, and marking the north limit of the first anticlinal roll mentioned in the railroad sections.

This roll is distinctly seen on the other side of the river in the cut of the Wilmington and Northern railroad, where, in spite of steeply dipping south-east cleavage planes, two well established dips of N. 24° W. 60° and S. 24° E. 60° to 80° were obtained.

South of these last dips, on the W. & N. RR., there is an appearance of a shallow synclinal basin exhibited in its south limb by a dip of N. 40° W. 40°, followed by a gentle anticlinal roll, dipping on the south side of the arch S. 45° E. 40°, and holding that dip to the end of the railroad tangent. The rock is everywhere marked with cleavage planes dipping S. 15° E. 80°.

Angelica creek, which divides this little patch of sandstone in half, shows a sandstone dip below the Land Improvement Company's dam of S. 35° E. 70, and further up creek near the public road and junction of No. II limestone a dip of S. 30° E. 35°.

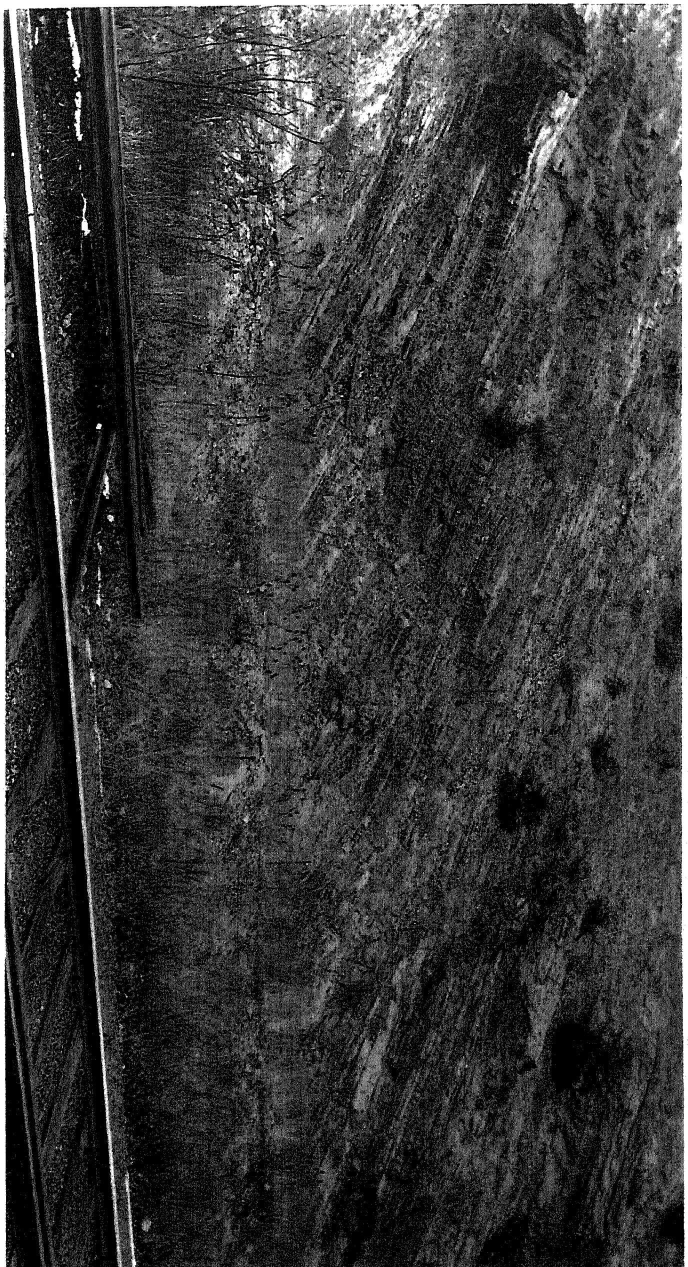


FIG. 7. POTSDAM SANDSTONE OF NEVERSINK HILLS, EXPOSED IN THE RAILWAY CUT, 3½ MILES BELOW READING. BERKS COUNTY, PA. - LOOKING NORTH. (PICTURE REVERSED.)

The small round hill to the west of the creek is also Potsdam and shows a dip on its summit of S. 25° E. 42°.

Returning to the east bank of the river, the Lover's Leap exposure on the railroad is duplicated on the river's bank by a dip of S. 50° E. 60°, and about 300 yards further south, yet north of small ravine, the second anticlinal is marked by an overturned dip of S. 55° E. 65°, and a regular dip on the south side close to the creek of S. 70° E. 60°.

The ravine marks the divide between Nos. I and II, the latter showing a dip of N. 70° E. 50°, though so greatly contorted and twisted as to render its accuracy problematical.

Limestone in turn is succeeded in about 800 feet by Mesozoic conglomerate close to the crossing of the second Wilmington and Northern bridge.

This, the most southern range of Potsdam SS. in the South Mountain district, extends east from the Schuylkill in a broad belt nearly a mile wide, completely covering the Neversink hills to their eastern extremity in Exeter township.

On the south it is everywhere overlaid by the limestones of No. II, which, starting at the Big Dam, sweep east to the Oley valley.

On the north the Neversink hills are divided from Mt. Penn by a trough of limestone running up through the town of Reading as far as the Mineral Springs road, the north edge of the Potsdam here swinging north and east over half of Dengler's hill, and up the valley of the Antietam creek south of the Babb's Tavern and Ohlinger Dam road.

The Potsdam stretches north through this valley as far as the 450′ contour line at the base of the Laurentian gneiss N. E. of the Stony Creek mills, where it turns back S. E. along a branch of Antietam creek past H. and D. Lorah's houses as far south as the forks of the creek below D. Endy's house, where it again turns sharply to the east, spreading over the hill north of the Oley Pike, gradually thinning east of M. Herbein's on that pike, and extending

in a strip about 500 yards wide to the small branch of Monocacy creek at K. Gerr's house.

Here it dies out, and the limestones lie immediately on the gneiss to the Oley Line hotel.

The south margin of this deposit is approximately the Oley Pike from the limit of the formation on the east as far west as small summit 370′, 3000 feet west of Jacksonwald, where the limestone swings in and occupies a narrow belt along the Antietam up to the 350′ contour.

The small rounded summit south of Brumbach's factory is composed of Potsdam quartzite, separated from the Neversink hill deposit by a strip of limestone.

The Potsdam S. S. main range extends south from the saw mill on the Oley pike east of Black Bear Inn, along small creek, passes over divide west of Philadelphia pike, and swings west past F. DeTurk's and G. Esterly's houses to the Schuylkill in a pretty straight line.

The *Neversink hills* show but few outcrops east of the railroad; one exposure is in a quarry north of Good's house on the north main anticlinal, showing about thirty feet of compact gray quartzite dipping S. 15° E. 48°. An immense amount of small boulders have rolled down the hillside into the Claperthal, covering the wood road passing through here, while the summits themselves are profusely strewn with the same.

The north leg of the south anticlinal is shown also by a dip well up in hill of N. 25° E. 50°.

Ore holes have been sunk further east, near P. Glaser's house, which show a little limonite ore, but nothing to encourage further exploration.

Passing to the Guldin hill anticlinal north of the Oley pike, dips are seen along its arch rising from the road of S. 15° E. 76° and N. 20° W. 54°.

Eight hundred feet up hill the sandstone is opened in a small quarry, where it exposes about twenty feet of grey quartzite dipping N. 20° W. 79° and forming a reef of rock extending up hill, dipping two hundred feet further on N. 18° W. 80°, and finally on the summit of the hill N. 14° W. 35°.

Spies church anticlinal in Alsace township is a probable extension of this, but is isolated from it by a belt of gneiss rocks a mile wide.

The arch is well marked on the eastern decline of this hill showing dips of N. 40° W. 45° and S. 30° E. 42°—the latter exposed in a small sandstone quarry of mixed quartzite with feldspar nodules and fine compact sandstone.

On summit, 950′ east of the Nigger valley, sandstone outcrops dipping N. 67° W. 60°.

This hill is one mass of sandstone boulders, and owing to steep inclinations, rendering its sides hard and dangerous to climb.

The road on its eastern flank is strewn with trap boulders for several hundred feet north of Jacksonwald, but no dyke could be detected on the surface.

The *terraced hill* between Jacksonwald and Oley line, and north of the pike at D. Snyder's house, shows two outcrops of sandstone, dipping in a small quarry on the first terrace N. 50° E. 32°, and higher up hill near the gneiss on the second terrace N. 10° W. 60°, though this latter dip is not very reliable owing to the small amount of outcrop.

To conclude the areas of Potsdam S. S. east of the Schuylkill it remains only to speak of the outlying hill south of Barnhart's dam, north of Reading, lying between the Pricetown road and the E. P. R. R.

This area is without the mountain district, but owing to the numerous doubts that had been expressed by various parties as to its age, I paid it a special visit. The locality is an interesting one, and, owing to considerable outcrops of slate along the public road and railroad here, dipping *towards* or *into* the hill, the latter had been called No. IV Medina SS.—the rock of the Blue Ridge to the north—on purely structural grounds, making the underlying slates Hudson River No. III.

These slates may be traced south from Center Square hotel, on the Temple road, along a low hill to the road going in N. E. along creek to Barnhart's mill dam.

Thus far they are undoubtedly No. III Hudson River,

dipping S. 60° W. 45° on the road at the southern base of the hill, close to the E. P. RR. track.

At this point I am inclined to think that the No. II limestones swing in along creek from the main valley, exposed in patches along the *east* side of the creek and along the railroad, as are the slates along the *west* side, and finally joining the limestones north of the Center Square hotel, thus completely surrounding the slate hill. It is true that the country to the east of the main creek, lying at the base of the sandstone hill, is covered thickly with sandstone boulders; but the evidence of the farmers, as well as occasional *limestone* boulders, confirms my belief in its existence here.

Rogers, on page 197, Vol. I, mentions a small body of limestone here which I failed to detect, but he is in error, I think, in calling these slates *Primal*, as he is in calling the exposure of hornblendic syenite in the small hill north of the dam an outcrop of *igneous rock.*

It is an outlying representative of the South Mountain rocks, here left exposed in a small low hill, between two areas of Potsdam sandstone.

The dip is N. 80° W. 40°.

The slates outcropping in railroad cut south of this stream and occupying the nose of the hill in question as far south as Mr. W. E. C. Coxe's house, are apparently No. III also, though an assignment of them to that horizon creates the necessity of locating a downthrow fault along the west base of the hill, completely burying No. II limestones and causing the slates of III to butt directly against No. 1 sandstone in the hill. They have south-east cleavage of about 32°, and dip *towards* the hill E. N. E. at angles of from 50°–60°.

They are not seen on the railroad for the first 400 feet below Barnhart's road, this space being occupied by decomposed sandstone also dipping *towards* the hill at an angle of 45° to 55°.

The east limits of the slate are marked by two opposing coves running up into the hill from the railroad track on north and from Mr. Coxe's house on the south. All question of the age of the hill itself will vanish by once walk-

ing over its summit, which shows some of the finest outcroppings of Potsdam sandstone or quartzite to be found in the district.

The crest is marked by the presence of tall pulpit rocks rising 40 feet high above the summit and frowning on the valley below.

Cleavage everywhere abounds as usual, showing the metamorphic influences under which this hill has gone. Its dips have been overturned, and, as is frequently the case further north, doubling the north limb under the anticlinal arch, which makes the formation appear to *overly* the valley limestone.

The dips are to the south south-east 55° and 60° on the south flank of the hill, whilst one dip to the N. W. of 80° shows on north side of hill.

Between Mr. Coxe's house and the P. & R. Rail Mill a low flat intervenes, where the rock is very much decomposed, but is mostly a mixture of slate and limestone, with the former predominating.

South-west of the rail mill the No. III slates of Cemetery hill appear and are in direct extension of the N. E. deposit, as well as the small patch of III on hill summit 1½ miles S. W. of Reading, in Cumru township.

The sandstone hill in question is only an off-shoot of the main Laurel hill—Mt. Penn ridge, and innumerable Potsdam boulders flank its sides and the roads at its base sufficiently to prove the character of their source and the top of the hill.

West of the Schuylkill there is a considerable development of Potsdam sandstone and slate, though none such seems to have been recognized by Rogers east of the Cacoosing creek, where he places this formation around the north flank of Milbaugh hill into Lebanon county.

Everywhere else, between the Schuylkill and the eastern extremity of Milbaugh hill, he makes the Mesozoic formation in direct contact with the limestones.

The first patch of sandstone shows along the Wilmington and Northern railroad, where, just south of the limestone,

a thin-bedded light-grey quartzite appears, apparently dipping N. 40° W. 72°, though greatly split up with cleavage.

Further south the dip changes to about N. 10° W. 60° in a gray quartzite. The dip further south is apparently S. 25° E. 80°, with prominent cleavage. The anticlinal showing here is probably an extension of the north arch in Neversink hills.

Further down railroad along tangent, and after passing out of the first cut, gray thin-bedded quartzite appears dipping N. 55°–70° W. 32°–40°, and runs along railroad cut in a waved line course.

The cleavage at right angles to the bed plates is slightly better marked, giving the rocks an apparent dip of S. 70° E. There is a thickness here of about 40 feet, Potsdam continuing along railroad for 300 feet, flattening in dip towards the south, and showing the position of the south arch of the Neversink hills in a dip of S. 45° W. 10°.

Just near end of cut, and nearly opposite signal tower where photograph was taken, see Plate 2, Fig. 6, the rocks display the same apparent non-conformability of bedding, due to the steep south-east cleavage 75° of two beds, inclosing another central bed comparatively free from cleavage.

The rounded hill on south side of Angelica creek is likewise composed of Potsdam quartzite, showing a dip near summit of grey and pink quartzite streaked with slate of S. 10° E. 42°, and greyish white massive quartzite on road at north flank near creek dipping about south 20°.

On the Schuylkill, just at small dam at head of Fritz Island, among massive boulders of white quartzite, a mottled slaty trap rock occurs. The surface is cut up with irregular cleavage joints, hiding all dips of rock, which shows a brown color, being chiefly composed of hornblende and feldspar. This is evidently the same rock that plays so important a part in the Island Mine, and an analysis of which will be found in the description of that opening on page ——.

Another patch of sandstone begins just west of Shepp's mill, Cumru township, and extends west to Mt. Pleasant hotel (five mile house) where it joins the larger body extending into Spring township.

It has been quarried in hillside just south of the Shillington road where it shows a dip of S. 25° E. 30°.

On road south from Shillington, Potsdam may be followed for three thousand feet, meeting the new red shale on hill summit north of J. Hill's place.

The marked change in the soil will serve to locate the division easily.

Two seams of slate show just south of Shillington, one close to the junction of No. II limestone, the second four hundred feet further south and just north of J. Hart's house.

There is another quarry in No. I showing massive sandstone and greenish chlorite slates, dipping S. 25° E. 40° about three fourth miles south-west of Shillington and close to the junction of the Mesozoic sandstone.

The slate ridge north of Five Mile house is No. I and immediately west of this Potsdam sandstone occurs on same hill, extending all over high ground to Reading and Columbia railroad.

At base of hill on railroad there is a small patch of slate dipping S. 45° E. 35°.

Potsdam sandstone boulders are spread all over flat along railroad, and cover hill to west of railroad shown at extreme west limit of map.

A small opening has been made at extreme west flank of this hill in hematite ore—now fallen shut.

The prominent ridge striking out north-east from the north side of this hill, is composed of coarse-grained basaltic trap, which is well exposed on the Tulpehocken creek about two miles above its confluence with the Schuylkill, in a limestone quarry. It occurs between slate and limestone, and is highly crystallized along face of slate. It is twelve feet thick at this quarry and explored along limestone quarry for fifty feet, and is about fifteen feet high.

This is the same dyke that occurs north of Tuckerton on the Reading-Leesport road.

South of the Potsdam hill on the extreme west limit of the map, and divided from it by a narrow cove, is a small body of gneiss, which is about the beginning of the main

body of azoic rocks of Milbaugh hill, the last representative of the Laurentian rocks between the Schuylkill and Dillsburg in York county.

CHAPTER V.

The Limestones of the Great Valley.—Siluro-Cambrian Magnesian Limestones.—Formation No. II of the First Survey.—Auroral and Matinal of Rogers.—Calciferous Sandstone, Chazy Limestone, &c., N. Y. Geology.

This formation, as a whole, appears to be at least 2000 feet thick, but is so complicated and contorted as to defy accurate measurement.

Its place in the series is next above the Potsdam sandstone formation No. I, and its outspread upon the map is colored blue.

It makes the plain at the north foot of the South Mountains—a belt of low land three miles wide at the Lehigh county line, two miles wide as it approaches the Schuylkill, and five miles wide on Lebanon county line.

Its northern border is the line of slate hills extending from Trexlerville, in Lehigh county, past Moselem, to Leesport on the Schuylkill. These slate hills represent the lower edge of the great slate formation No. III, 6000 feet thick, which stretches across Berks county from east to west, and from the edge of the limestone to the North Mountain; and beneath this edge of No. III slate the upper beds of the No. II limestones sink northward.

The limestones once covered the South Mountains. Now nothing remains of them on the mountains. But remnants are found in several valleys among the mountains, and these remnants will be described in detail in this chapter. South of the mountains the limestones plunge southward underneath the Mesozoic red shales and sandstones of Berks, Bucks, Montgomery, and Chester counties, and form the floor of the old estuary, as they do in Lancaster, Lebanon, York, and Adams counties.

The geological age of the whole formation is determined

by its topographical relationships with the formations above and beneath it. The belt can be traced uninterruptedly from Canada to Alabama; and the rocks which sink northwards in the great Cumberland Valley, rise again and again to the surface in the great coves and valleys of Middle Pennsylvania, Virginia, and Tennessee, always covered by the same No. III slates, and always holding certain fossil forms which characterize the Calciferous, Chazy, and Trenton limestones of New York and the Western States; although these fossil forms are indistinct and hard to find in the limestone outcrops of the Great Valley, except at scattered localities, where they are abundant. (See Vol. I of this report.)

The limestones of the coves and valleys of middle Pennsylvania are mainly compacted and hardened by pressure and age. But these same limestones appear along the foot of the South Mountains not only hard, flinty, and compact, but more or less semi-crystallized, as if they had undergone a further change; and in some places they are almost converted into marble. In the Little Valley (Chester county) they are completely metamorphosed into white marble; but no true marble is known in the belt of the No. II limestone in the Great Valley in Berks county.

These limestones vary in color from nearly pure white, light gray, and light blue to deep blue black; and chemical analysis shows that the whiteness is generally due to a high percentage of magnesia, and blackness to disseminated *graphite*, or carbon. Other shades are produced by the presence of large or small quantities of iron. It is the oxidation of iron in the rock which gives the rich orange color to the limestone soil; and where the iron is more abundant the color is more decided.

The analyses made at Harrisburg in 1877-'78 (Report MM, page 312,) show that all the beds contain some carbonate of magnesia; some very little, only three to five per cent., others so much as to be not *limestone* beds, but *dolomite* beds; that is, half carbonate of lime and half carbonate of magnesia; always with some insoluble matter

averaging seven per cent, but in some cases as much as fifteen per cent.

What is very remarkable, nearly pure limestone beds and nearly pure dolomite beds alternate with one another in the same quarry—thin limestones between thick dolomites—thin dolomites between thick limestones—all perfectly regular in their bedding. Three beds have been noticed, each only a few inches thick, the middle one being limestones and the other two dolomites. A single thin dolomite bed will lie among a number of thick limestone beds. On the other hand a thin limestone bed will lie in the middle of a series of dolomite beds.

It is noticeable that the limestone beds have the least percentage of the insoluble silicates of alumina, &c., and the dolomite beds have the most; a fact which seems to connect the magnesia with the insoluble matters;* a fact also of importance to iron makers, and also to farmers, because the soils are made out of the underlying rocks.

It must be remembered, however, that in the natural process of converting limestone *rock* into limestone *soil*, the carbonate of lime is dissolved by the rain water and carried off, so that very little remains in the soil, and the farmer has to lime it anew.

Rock-crystals (quartz-crystals) are often found in the limestone beds of the Great Valley. They have been formed from the small percentages of silicates which the analyses exhibit, as above stated.

Flint balls, or masses of *chert*, are abundant in some of the limestone beds. These are now generally understood by geologists to be *fossil sponges* or other like organic creatures, living in those ancient waters, the animal itself being petrified and nothing but its shape preserved, and in most cases not even that.

Caverns are a striking feature of the limestone belt of the Great Valley. They are numerous and large. When their roofs fall in *sink-holes* are formed in the fields. These are so numerous that the whole belt may be said to be pitted

*Report MM 1879, pages 360, 361.

with them. They show how the destruction of the limestone formation has been going on in past ages, and new ones prove that it is still going on, probably at the same rate. At the bottom of the caverns, and beneath the sinkholes, underground waters flow and issue at springs in the beds of the deeper valleys. This explains the scarcity of brooks and creeks in some parts of the map.

Many ancient caverns exist which are now dry, the underground waters having found other channels. Others are completely choked and filled with limy, irony clays, in which brown hematite ore deposits are being made. Others have been thus filled and their roofs have been dissolved away; and these are the pot-deposits of brown hematite iron ore which abound in the limestone belt. In Lehigh county some of these are very large and deep. In Berks county the Moselem mine is the most important example.

Theoretically such a deposit of ore ought not to be deeper than the place where its ancient water course came out on the Lehigh or Schuylkill river, but, considering the chemical action of the water on the floor of the cavern, and in fissures descending beneath the floor, some slight additional depth must be allowed. It is a practical geological rule, however, that an owner of an iron bank in Berks county cannot expect to find ore below the plane of 200′ above tide, which is the level of the bed of the Schuylkill at Reading, and the level of the bed of the Lehigh at Allentown. An allowance must also be made for the grade of the descent of the underground water from the mine to the outlet. An iron bank near Reading may be deeper, therefore, than one at Kutztown or at Womelsdorf can be. Topton Junction, for example, stands at 485′ A. T. Subtract 200′ from 485′ and we have 285′ as the possible depth of a cave or sinkhole. But Topton Junction is 18½ miles from Reading. If we only allow a fall of 5′ per mile for the cavern waters we must take off 92′, leaving only 193′ for the possible depth of a cave, or of an iron ore deposit, at Topton Junction.

Beyond some such properly calculated depth sinking for iron ore *of this kind* is a hopeless affair. It is quite differ-

ent with the hard iron-ore beds of the mountain district, which have nothing to do with limestone caverns.

The vast quantities of clay—white, yellow, brown, and black—in and with which the brown hematite iron-ore deposits lie in these ancient unroofed caverns, strike one with astonishment. But they are easily explained.

The limestones of the valley at one time rose 2000′ into the air above the present surface of the South Mountains. All this had been gradually dissolved and carried away. An average 93 per cent. of the whole mass was soluble, and went off as magnesian-lime water ; 7 per cent. was insoluble clay iron-sand, and went off more slowly as river mud ; all that the caves and holes could hold of it remained behind and still remains :—2000′ of rock contained 140′ of clay. The small fraction of *what was left* from the subsequent erosion of the clays is quite sufficient to account for all the ore deposits of the limestone belt.

Lime quarries are numerous ; mostly small for local farm use in building and lime burning, some of them very large, supplying blast furnaces, and shipping quicklime to distant markets.

Lime burning is an important interest in Berks county. But the business is not carried on to nearly the extent it was a few years back, when some of the larger quarries in the eastern side of the county supplied a wide extent of farming land in the New Red shale country beyond the Montgomery line. The principal cause for this change was the location of railroads which brought up the burned product of the large kilns of the Schuylkill valley, restricting the production of the smaller kilns in Berks county, which had moreover usually to contend with a superior quality of stone.

A vast amount of wood was formerly burned in these kilns, all of which helped directly towards stripping the forests; but to the best of my knowledge, all the kilns now in operation use coal, which in turn has restricted the production of burned lime to those districts most advantageously located for receiving the coal from the railroads.

Almost every farm in the mountain district exhibits a

picturesque ruin of an old limekiln, its walls showing wide gaps, and its exterior and interior alike given up to the wild ivy. One ton of coal is burned for every one hundred bushels of stone on an average, and the demand will of course vary with the nature of the farming land, being anywhere from twenty-five to seventy-five bushels per acre.

Much of this burned lime goes into the red shale country, and wherever used it has visibly improved the grass and grain. Indeed most of the red shale bottom land is preferred for pasturage and grazing, and when well watered a few weeks residence will improve cattle wonderfully. The best timothy hay is taken from this land for the same reason. For building purposes and masonry uses generally the lime burned from the pure limestone—that containing a high percentage of $CaCo_3$—is preferred to the magnesian product, being said to slake quicker and make *fat* lime, swelling to three times its bulk when mixed with water, but at the same time requiring a longer time to *set* than the magnesian stone.

I. The Limestone of Oley Valley, Dale Forge, and Hampton Furnace.

The areas to be described are those of *Oley valley*, with its extension, a belt five hundred to one thousand yards wide, stretching along the foot of the mountains westward to the Schuylkill river and eastward to the Lehigh county line; also Dale Forge valley; and at Hampton furnace.

A small area of limestone is said to exist close to the creek back of Furnace hill, in Earl; but Potsdam fragments so cover the surface that I could not verify the fact.

Blue limestone predominates in most of the small, imperfectly opened quarries.

It rests directly on gneiss (without the intermediate Potsdam sandstone,)—in the southern part of Dale Forge valley, (Washington T.,)—at Keim's quarry (Rockland) west of the Oley-Exeter line,—in the rounded gneiss hills of Exeter,—at the east end of Reading,—and in several places along the narrow valley from Boyertown to the Lehigh county line.

The lime rock is generally fine-grained and semi-crystal-

line, with a glassy luster; effervesces when touched with strong acid; contains various amounts of magnesia.

The Hampton furnace quarries demand attention first. These are located just across the Lehigh county line in Hereford township, Berks county, and show quite an extensive limestone outcrop along the south side of the Perkiomen creek and about one third of a mile west of the furnace. The valley of this creek, though nowhere exposing Potsdam sandstone in place, is no doubt flanked with that rock, for its soil is a mixture of decomposed sandstone and slate, mixed with No. II limestone.

The Siesholtzville Mines.—The prevalence of limestone in these mines would seem to prolong this formation to that point, but all exposures cease at A. Shantz's quarry, about one third of a mile west of the county line. The limestone is opened in six quarries along the line of its outcrop, and is from 150 to 200 feet in thickness.

Potsdam sandstone is met with about 35 to 40 feet south of the quarries, extending over hill top 800′.

The most eastern outcrop of the limestone is close to the creek near the old furnace dam.

The first opening in it is at David Benfield's quarry (No. 1 Index Map), dipping N. 18° W. 79°, containing an impure blue stone unfit for burning in the east end, and a dove-colored dolomitic stone in the west end, which is quarried and burned.

Exposure here is about 125′ thick.

No. 2 quarry, the next one further west, is owned by James and Lewis Christman, and presents about the same general characteristics as Benfield's.

The dip here is about N. 21° W. 83°.

No. 3 is a small quarry belonging to Jacob Christman, and was idle when visited. The dip here was N. 30° W. 87°, and exposure about 90 feet thick, mostly compact white dolomitic limestone.

No. 4 is Henry Roth's, which was likewise abandoned.

No. 5 is Jonas Shaub's, which was selected for analysis both on account of its presenting a fine exposure (150 feet) of limestone for a fair average sampling, and because it was the only one actively worked at the time.

Mr. McCreath reports the following results:

Carbonate of lime,	52.857
Carbonate of magnesia,	42.779
Oxide of iron and alumina,	.650
Phosphorus,	.004
Insoluble residue,	3.890

This will show at a glance the dolomitic character of all these limestones, but from this sample there was left out naturally a 6′ bed of limestone, so hard and siliceous as to be unfit for burning. It is, consequently, left untouched by the quarrymen, who call it "firestone" from its indestructible character when burned.

There is a kiln with a capacity of burning 700 bushels of stone at this quarry, sold for fertilizing purposes to the neighboring farmers @ 10 cents per bushel.

A large trade was formerly carried on in these quarries in supplying the old Hampton or Sigman furnace, and the character of the limestone formed a good flux for the silicious mountain ores.

No. 6 belongs to A. Schantz, a small undeveloped quarry only opened for his own use.

The whole outcrop is interesting here, inasmuch as all attempts to trace it east into Lehigh county and west from Schantz's quarry have proved failures, and its preservation here with a thickness of 150 feet, steeply upturned and exposed to abrasion as it is, was rather unlooked for.

Dale Forge valley, partly in Hereford and partly in Washington township, is a charming spot, hemmed in on all sides by high and rugged hills, and plentifully watered by the Perkiomen West Branch.

It comprises about 350 acres of limestone soil, in which four quarries and two limonite ore holes have been opened.

It was settled many years ago and so named from the old

Dale forge, mentioned by D. M. Keim, Esq., in the Berks and Schuylkill Journal, as in active operation in 1831. This may probably be the old forge of John Rush, where the Siesholtzville ore was first successfully tested.

The old Mount Pleasant forges are situated further down this valley near Barto.

The most southern exposure of limestone in this picturesque valley is about 500 feet south of the Dale Forge hotel, where it occupies a narrow belt at the west side of the creek, flanked on both sides with Azoic rocks, the intervening Potsdam SS. formation being absent here and along the eastern side of the whole valley.

From its most southern exposure the limestone extends in a narrow strip as far as the cross-roads at the hotel, and then following the *east* side of the branch creek, it can be traced across the public road, outcropping in creek just below J. Rush's house.

From there it swings around the small outlying Potsdam hill up to about the 650′ contour at the public road to Landis' store.

It then swings N. E. past Trollinger's quarry as far north as the junction of the 630′ contour with the main creek, and then east back of lime-kiln and school-house to branch creek, when it turns south around west flank of gneiss hill to the starting point near the hotel.

A limonite bed is exposed near D. Reichard's place, very near public road, and close to the junction of limestone and gneiss.

This bed may be traced north through the Schall estate to near small limestone quarry at branch creek, where it was formerly somewhat developed, and showed, according to Mr. D. H. Schall, a 7′ bed of ore.

Limonite was also found in the hole north-east of Rush's mill, close to and south of the Huff Church road, from which 4,000 or 5,000 tons of ore were mined. (See Chapter VIII, page .)

Of the limestone exposures the most northern is seen in a little hole close to the Perkiomen creek dipping S. 60° E. 88°, three feet of blue limestone.

A little S. W. of this exposure the limestone is opened and worked in *Peter R. Trollinger's quarry.* When visited the quarry was being operated by Messrs. Cline and Weiler.

It is a dark blue quartzose limestone, probably 40 feet thick overlaid by 2 or three feet of light grey decomposed slate conformable with it.

The limestone is for the most part massive and of fair quality.

In the south end of the quarry there is a shallow synclinal crimple, the arms of which dip S. 20° E. 43° and N. 37° W. 6°. In the north end of the quarry the dip is S. 18° E. 29°. The limestone is burned on the ground and used as a fertilizer in the neighboring district.

The next opening is just east of the public road, about 800′ north of D. Schall's house, on the Schall estate. This quarry was not being worked but is said to have yielded an excellent furnace limestone.

It is white in color, hard and compact, showing 20 feet of limestone overlaid conformably by 4 to 5 feet of worthless grey cherty rock, both dipping S. 27° E. and 69°. Over the latter there is a layer of 3 feet of bastard limestone largely mixed with slate, and above this 6 feet of black and grey slates, greatly crushed, and apparently dipping N. 55° W. and 41°.

Further south and just below mill dam Schall's largest quarry is located.

This quarry has furnished quite a large quantity of dolomitic limestone, highly magnesian and showing a great similarity of composition to the Hampton Furnace limestones, except that its color is almost entirely blue.

The exposure shows about thirty feet of massive stone, dipping N. 35° W. 45°, capped with four to six feet of black slate conformable with it.

The stone is burned on the ground in a double kiln, and is used as a fertilizer on the rather sterile hills surrounding the valley.

Its analysis, made by Mr. A. S. McCreath, shows:

Carbonate of lime,	53.839
Carbonate of magnesia,	42.042

Oxide of iron and alumina, ...	.810
Phosphorus, ...	.008
Silicious matter, ...	3.410

A slaty variety of the same outcrop is exposed just at spring-house and also a little further south on the Barto road, dipping N. 32° W. 20°.

Schall's Mineral Spring.—Immediately below dam and back of spring-house there is a small mineral spring, which, if thoroughly cleaned out and walled up, might furnish some very good mineral water.

Iron is its chief constituent, as is evident from its taste and from the deposit of the brownish red scales of the hydrated peroxide of iron which line the sides of the well and overflowing stream.

A qualitative test by Dr. Stanley Smith of Reading showed in addition, free carbonic acid and the carbonates of lime and magnesia.

Rush Quarries.—There are several small openings on the property of J. Rush, one considerably developed on roadside about one half mile north-west of Dale Hotel, where a dark blue massive limestone, similar to that in Schall's quarry, is worked. It is twenty-five feet thick dipping S. 6° E. 60°, overlaid with six feet of damourite slate of a brownish red color and greatly decomposed. The dip of this latter is S. 24° E. 16°.

On branch creek about one hundred yards west of this quarry, several small openings have been made in the hillside, the most southerly showing a dip of S. 10° E. 58°, and about one hundred feet up stream limestone dipping about N. 25° E. 60°. There is a very fair quality of stone exposed in these openings, though they are all small and but slightly developed.

All exposures butt directly against the gneiss; in the south quarry the limestone apparently dipping under the Laurentian rocks, due no doubt to its being overturned.

Taking up the southern range of limestone, which, starting at the Lehigh county line near Treichlersville, extends almost continuously to the Schuylkill below Reading, spreading out into the fertile Oley valley, we have first to

deal with the eastern outcroppings, mostly in Hereford township.

There is every probability that limestone occupies the low country north of the Mesozoic Red shale in this township as it does further west--but owing to the limited number of exposures such a generalization may fail.

The farmers report meeting with limestone boulders in many of the fields, but this valley is in such a high state of cultivation that these evidences are not conclusive except for the fact of two small exposures in place, one at the creek forks at Krieble's oil mill, and the other on the Treichlersville-Palm pike about ½ mile S. E. of the former place. These outcrops are insignificant by themselves, but are influential when duplicated by others about a mile southwest in the same valley.

About 200 yards N. E. of the toll-gate on the Clayton pike, and a short distance up from creek, there is an old limekiln and quarry, which furnish the best testimony of its occurrence here.

The limestone exposed is of poor quality and only about 10 feet thick, greatly mixed with slate. It dips to the south-east.

In a direct extension south-west of this outcrop is the exposure covering the outlying ridge south-west of A. G. Clemmer's house.

Clemmer's quarry.—This gentleman has opened quite an extensive quarry almost on top of the hill.

The limestone occupies a few acres of ground in the shape of an oval, extending from Clemmer's house to within a short distance of Claytonville and down to Perkiomen creek.

The creek divides it from the Mesozoic red sandstone.

The large quarry is about 50 feet long and 30 feet deep, and shows about 40 feet of good white magnesian limestone. In some places it is considerably broken up with cleavage, but as a rule it occurs massive.

There is about 4 feet of dirt covering on top of quarry.

The dip here is S. 65° E. 35° on the western side of the quarry.

About 50 feet further up hill there is a smaller abandoned quarry, showing a rather more cherty limestone dipping S. 63° E. 40°.

All the limestone from these quarries is burned in two kilns situated on the small creek close to Mr. Clemmer's house. They are run about 3½ months in the year, burning about 1600 bushels a week, for fertilizing purposes, selling at 11½ cents per bushel burned.

An analysis of A. G. Clemmer's quarry by McCreath shows:

Carbonate of lime,	54.714
Carbonate of magnesia,	43.380
Oxide of iron and alumina,	.990
Phosphorus,	.003
Silicious matter,	1.220

Diehl's Quarry.—Further south-west in Washington township, about ⅛ mile below Claytonville, the same limestone is opened on property of Henry Diehl, deceased, in Michael Diehl's quarry.

The outcrop is not continuous from Clemmer's opening, being cut off or concealed by Potsdam SS. boulders between Claytonville and the small branch creek.

It was very hard to get an average sample of stone here, as the quarry showed stone of a very mixed quality—a good dolomite in one place and a very silicious limestone in another.

The best stone was in the western end. As very little had been quarried at the time of my visit, no sampling could be made of the stone used in the kilns, so that pieces were taken from all beds in the quarry, which may account for the great amount of silicious matter shown in the analysis by Mr. McCreath, which is as follows:

Carbonate of lime,	26.053
Carbonate of magnesia,	19.077
Oxide of iron and alumina,	2.330
Silicious matter,	50.610

The dips are all south-east, varying in different parts of the quarry as follows: 30°, 45°, 46°, 48°, 50°. The quarry is shallow and shows about 25 feet of white and bluish-gray limestone.

Two kilns of a combined capacity of 900 bushels, burn between 1500 and 1600 bushels a week @ 11 cents per bushel.

The foot-hills of the South Mountains from here to the West Branch Perkiomen creek are everywhere flanked by Potsdam sandstone and quartzite, which spreads completely over the valley against the red shales, the creek marking the divide between the two formations.

The next exposure of limestone occurs south of Eshbachville in Washington township, and it extends from here to Boyertown in an unbroken stretch.

The limestone area just south of Eshbachville is about 2500 feet wide, extending from the Reading road on the north, where it lies against a small exposure of Potsdam sandstone, to the Swamp creek on the south, which divides it from red shale.

The first opening in it is at the

Oberholtzer Quarry,—situated about ½ mile N. N. E. of Bechtelsville in Washington township, between the public road and the Colebrookdale R. R. It is owned and worked by Jacob Oberholtzer.

Four specimens (see catalogue, page —) were obtained here from as many different varieties of stone, which varies from a grey cherty limestone through dove color to a hard massive blue stone.

The limestone is a true dolomite. The beds are all conformable, lying very flat, with a dip of S. 40° E. 12°-15°. The greatest exposure is about 30 feet thick.

Good limestone is exposed in the south and east sides of the quarry, and at the time of visit, June 7, 1882, the north side was being uncovered.

There is about 12 feet of a yellow clay stripping over the limestone.

From 500 to 1500 bushels of stone per week are quarried here, burned in two kilns, with a capacity of 1300 to 1400 bushels per week.

The limestone is all burned for fertilizing purposes, bringing 12 cents at the kiln.

The following is Mr. McCreath's analysis of a mixed sample selected from all beds in the quarry:

Carbonate of lime,	51.839
Carbonate of magnesia,	40.523
Oxide of iron and alumina,	.860
Phosphorus,	.005
Silicious matter,	7.170
Total,	100.397

From Bechtelsville to Boyertown the limestone is everywhere present, varying from 500 to 2500 feet wide, divided from the Azoic rocks of the South Mountains on the north by a narrow strip of Potsdam sandstone, and from the Mesozoic red sandstone on the south by the Swamp creek and its branches.

At Boyertown the Potsdam sandstone of Stauffer's hill closes up against the New Red on the Reading road, and at best leaves but a narrow tongue of limestone intervening. This latter, if present at all, is completely hidden by sandstone boulders from the little hill back of the old Mount Pleasant Seminary in the borough of Boyertown.

In this distance of over 2 miles the limestone is but once opened, viz: at

H. Geist's (Miller's) Quarry,—½ mile S. W. of Bechtelsville, in Washington township.

This quarry has not been worked for some time, and exposes about 30 feet of blue and dove-colored limestone, interstratified with inches of limestone shale. It is very silicious, owing to its close proximity to the Potsdam sandstone occurring in the hill back of it. The blue limestone occurs in massive beds from 2 to 5 feet thick, but is filled with nodules of white feldspar, which considerably deteriorates its commercial value and increases the percentage of insoluble matter.

The dip is about S. 85° E. 10° to 15°.

The following is McCreath's analysis:

Carbonate of lime,	19.821
Carbonate of magnesia,	14.529
Oxide of iron and alumina,	.810
Silicious matter,	64.370

Individual beds in this quarry will give better results than the above, which represents an average of the whole opening.

Limestone outcrops south on the road near Young's mill, which is built on limestone, and at Oberholtzer's mill, but no dips could be obtained at either place.

Before passing west of Boyertown some mention of the clay deposit, recently opened about four hundred yards W. S. W. from New Berlin station and close to the east side of the Colebrookdale railroad, is in place.. The land is owned by Messrs. Landis, Mutard, and Eshbach, and is leased by Schaeffer and Gresh. The clay is of a honey yellow color, due to contained iron, and is mostly of limestone origin, though here very argillaceous. About ten feet of it had been exposed when visited, lying very flat. No bottom rock had then been reached, but work had only been recently commenced there—March 1, 1882. The clay is mixed with sand from the Mesozoic formation, which adjoins the clay deposit on the east, and an excellent quality of building brick made.

There is one oven erected on the property with a capacity of burning 150,000 bricks.

13,000 bricks are burned a day, selling at $6 50 per thousand at the oven.

Eight men and as many boys are employed there. Fourteen days (exclusive of rainy weather) are required to turn out a finished brick from the raw material.

A shaft was put down through the same deposit a little further south on property owned by the above and Messrs. Focht and Gottschall; but no differentiated record of it could be obtained.

After sinking seventy feet through a mixture of clay and slaty limestone, and a little hematite ore, the hole was abandoned.

From the Lehigh county line to Boyertown the course of this narrow limestone valley has been about parallel to the Montgomery county line or about S. 40° W. From Boyertown west to Earlville on the Manatawny, where it spreads out into the Oley valley, it swings decidedly to the west, until at the latter place its strike is north of west.

The basin is a narrow one as far west as Greshville, rarely *over* eight hundred feet and generally *averaging* under four

hundred. As far as Gresh's lime-kiln on the Reading road, about three fourth miles east of Greshville, it is everywhere in conjunction with the feldspathic gneiss hills of the South Mountains, the Reading road approximately marking the divide.

On the south it is as usual flanked by the Mesozoic red sandstone and the greenstone trap of Gabel hill.

The deep mines at Boyertown all show a considerable limestone area in their lower workings, which probably once held its iron treasures on its surface as bog ores.

A short distance beyond the Douglass line, and just at the first public road leading up the hill to the north, the white sandstone of No. I comes in and continues to flank the north side of the valley uninterruptedly to Earlville.

The Mesozoic shale and sandstone still occupies its position on the south, its conglomerate member not being met with until the Manatawny is reached.

From Greshville west the limestone spreads out considerably, probably averaging 1500 feet wide as far as Earlville, and *generally* confined between the Reading road and the small stream that usually marks its division from the New Red in this part of the range.

Limestone is not opened anywhere in Colebrookdale township, which seems strange considering its railroad facilities and other advantages; but shortly after passing into Douglass township it is finely opened about ¼ mile N. E. of Greshville, at

Levi Gresh's Quarry.—This quarry is owned by J. Livingood, of Reading, and is located between the Reading road and the trap hill on the south.

It is one of the largest and best quarries in this part of the county, though its stone is very hard and rather expensive to quarry, having been somewhat metamorphosed and crystallized by the proximity of the trap dyke.

There is from 60 to 80 feet of good blue and white stone exposed here, dipping in the south side of the quarry S. 50° E. 54° against the trap, though showing a slight roll in the north side dipping N. 40° W. 60°.

Levi and David Gresh lease this quarry, and burn prob-

ably 30,000 bushels a year in the kilns on the Reading road at the foot of the hill.

The selling price now is 12 cents per bushel, but formerly, before the days of the railroad with the whole Montgomery red shale country to supply, 75,000 bushels a year were sold here @ 16 cents.

Several adits have been driven from quarry into the trap hill in search of iron ore, but hitherto without success.

The quarry was idle at the time of my visit, but is generally an active participant in the limestone output of the region.

The following is McCreath's analysis:

Carbonate of lime,	87.267
Carbonate of magnesia,	8.324
Oxide of iron and alumina,	.810
Phosphorus,	.006
Silicious matter,	3.480
Total,	99.887

From Gresh's quarry west the limestone occupies the north side of the Reading road as well as the south as far as J. Beck's house, about one mile west of Greshville.

The first opening met with is about ¼ mile west of Greshville and about 200 south of Reading road, where on the east side of the road to Neiman's mill the

Davidheiser Quarry is located. This quarry is owned and worked by J. Davidheiser, who has also made two more small openings further west on summit of hill, one north of the road in field where the dip is S. 3° W. 12°, and the other near south side of road, dip south 30°.

Neither of these latter have been opened sufficiently to expose anything but surface stone, which is a gray magnesian limestone, rather slaty in the south opening.

His largest quarry, first mentioned, was also idle when visited, and showed about 25 to 30 feet of fair quality white and blue magnesian limestone, dipping at north end S. 40° E. 55°, and at the south end a slaty variety, dipping S. 42° W. 70°, probably cleavage.

The following is an analysis of this stone:

Carbonate of lime,	55.053
Carbonate of magnesia,	38.094
Oxide of iron and alumina,	.730
Silicious matter,	6.280
Total,	100.157

Keely Quarry.—This quarry, owned by Henry Keely is situated close to Davidheiser's, and on the *west* side of the road to Neiman's mill. It was abandoned and full of water when visited, though exposing about 15 feet of limestone, blue in color, quartzose, and with streaks of white calcite; very hard and free from cleavage.

The dips vary from S. 15° E. to S. 4° W. 40°-64°.

The stone is about the same quality as the neighboring quarry, as the following analysis by McCreath will show:

Carbonate of lime,	54.643
Carbonate of magnesia,	41.598
Oxide of iron and alumina,	.750
Silicious matter,	3.400
Total,	100.391

This quarry will always have to contend with a great deal of water, for a branch of the Ironstone creek runs right through its centre.

There is about 10 feet of clay covering over it.

Fryermuth's Quarry next claims attention, situated in the south-east corner of Earl township, close to the meeting point of Earl, Douglass, and Amity, and about 400 feet south of the Reading road.

It is owned by Nicholas Fryermuth, and exposes about 15 feet of limestone, slightly magnesian and very silicious. The dip is slight, S. 20° E. 15°, but the limestone is greatly broken up with marked cleavage planes dipping S. 80° W. 80°, splitting it up into small chunks. It is mostly burnt for private use.

Rapp's Quarry is located on land of Peter Rapp, about 300 yards west of Fryermuth's quarry and about 1¼ miles S. E. of Earlville.

It is close to the Amity-Earl line and probably in the latter.

It is only partially developed, its product being used on Rapp's farm, and shows about 12 feet of blue limestone and

calcite mixed with quartz veins, of rather better quality than Fryermuth's. The dip is S. 23° E. 32°. The stone is burned at quarry.

The analysis shows :

Carbonate of lime,	63.928
Carbonate of magnesia,	12.884
Oxide of iron and alumina,	1.730
Silicious matter,	20.110
Total,	98.652

Oley Valley.

Between Rapp's quarry and the Manatawny there are no openings. The limestone keeps about the same width until it strikes the creek at Earlville, when it swings suddenly to the north along the Manatawny, spreading out over ¾ of Oley township, and creating the beautiful valley of that name.

This township, comprising about 23½ square miles, is practically one garden, for fully ⅞ of its soil is under cultivation.

Well watered by the Monocacy and Manatawny with their many branches, and with an excellent natural soil, it offered many inducements to the early settlers of the county who first built their rude cabins here.

Shut in on three sides by the South Mountains and practically on the fourth by the high lands of Amity township, this magnificent farming land needs but the promised Oley valley and Lehigh railroad to resuscitate its sluggish people and treble the output of its grain and cereals.

History has left its landmark here, as this was a portion of the Manatawny grants, the deeds for which were made out in England before William Penn left for this country. Mr. DeTurk's house bears the date of 1766, whilst William Weidner's house is older still, having been built over 150 years ago.

Its early inhabitants were always on friendly terms with the original "lords of the soil," the Delaware Indians, so that the history of this charming valley is one of almost continued peace and prosperity.

Just before harvest time this beautiful undulating plain seems to be one vast grain field, all the more noticeable and picturesque for the rugged and sterile character of its surrounding hills. In addition to the great development of the limestones of No. II in the valley—probably 1500 feet thick—the western part of the township shows a considerable outcropping of the Oley valley slates, which, be they No. I or III, are arranged in three well-marked groups, as will be noticed on inspecting the Index map.

To confine ourselves at present to the limestones however, and resuming the rotation of individual quarries and outcrops at Earlville, we find frequent openings on and contiguous to the banks of the Manatawny.

Southwest of Earlville and on small road along creek to High's mill, there is exposed in the road cut a peculiar weathered rock greatly decomposed and of a yellowish color.

It has in some places the appearance of rotten quartzite and in others of a green talcose slate, when again it becomes fibrous and partakes of the character of asbestus.

The rock for the most part seems to be feldspar, and may probably be No. I though unlooked for here. The whole region here shows considerable magnetic attraction and being close to the Mesozoic conglomerate occurring on the opposite side of the creek, the locality shows features similar to the Boyertown ore deposit.

The limestone proper crosses the Reading road about one hundred and fifty feet east of the Earlville hotel, curving north over the end of the dying Fancy hill anticlinal, following the 300′ contour closely to the Powder Mill valley.

From there it passes in a narrow strip along the Manatawny where the Stone Cave-Rabbit hill anticlinal is cut through by that stream.

The eastern boundary of the limestone hugs the same contour closely on the east side of the creek, passing east of Stetler's and Steppleton's houses to S. Kaufman's at the Beaver dam where it is quarried, continuing north to Mathias' mill south of Spangsville, where it is cut off on the *east* side of the creek by the Potsdam sandstone.

From Spangsville to the tan-yard, three fourth miles north east of Pleasantville, the Manatawny everywhere divides the formations Nos. I and II.

From this latter point, the limestone swings N. N. W. to the mill about one fourth mile south-west of Pikeville and thence north-west along the Pike-Oley line to Pine Creek, about three fourth miles below Lobachsville.

Two enclosed patches of limestone are to be noted here, one occurring south of the road from Brumbach's to Peters' mill, occupying the crest and side of the flat hill there as a tightly folded synclinal, and apparently surrounded by Potsdam white sandstone.

The general flatness of the valley here covered with boulders, some even derived from the gneiss hills to the north, makes it difficult to define the exact boundary between sandstone and limestone.

The second patch of No. II occurs about one half mile north-east of Peters' mill, occupying a small hill there, abutting on its north side against the Laurentian gneiss of Angstadt hill, and otherwise surrounded with Potsdam S. S. J. Keim's quarries are located there.

The general mass of limestone extends west from Pine creek to a point on branch creek from Connard's paper mill, about three hundred feet north of E. Levan's house. Here it crosses the creek and occupies a narrow strip fifty to one hundred feet wide along its *west* bank as far as the road from B. Yoder's to Friedensburg, where it is last exposed in a small quarry dipping S. 30° E. 38°. The east side of the creek is Potsdam S. S. and the limestone is flanked on the west by the Oley valley slates, which here appear to be unconformable to the limestone and dip toward it.

Limestone is found on the Furnace creek as far north as a point one hundred feet south of D. Weiser's saw mill, ending there in a wedge-shaped body flanked east by Potsdam S. S. and swinging W. S. W. around Bertolet's slate hill, on to the Little Manatawny.

Passing through the slate hill in a narrow strip along

stream, it spreads through the Weaver and Hunter mines up to the head waters of the Monocacy creek.

Diligent search for it was made down along the east bank of the creek and between the creek and the large slate hill; but if it exists at all, which is doubtful, it is so completely and effectually covered with slate detritus and sandstone boulders as to defy recognition. Could it have been recognized and found dipping under the slate it would have proved the latter to be No. III, and likewise decided the age of the rest of the range with which this slate hill is connected, occupying all the western part of Oley township as far south-east as the Yellow House.

As it is, the position of the slate here, as well as its adjoining the gneiss hills along the Oley-Exeter line, favor its being No. 1.

The limestone is first met with on the Monocacy creek just east of N. Knabb's place, swinging south to join the main body of No. II at the Oley Line hotel, and to extend with it westward to the Schuylkill.

Everywhere adjoining the slate, the limestone shoots out slender arms into it, until finally along the Lime Kiln creek (west branch) it seems to cut clean through the slate from the Oley-Exeter line to G. Raudenbusch's house, there joining the main mass and spreading with it over the valley.

Similarly isolated is the slate hill extending from J. G. Fischer's place to the Yellow House, and in both of these instances dip evidence is not wanting to ascribe the later age to the slates.

The southern margin of the limestone extends from High's mill in a nearly parallel line to the Amity township line at the Lime Kiln creek.

Its southern boundary is the Mesozoic conglomerate which, crossing into Oley east of L. J. Bertolet's house, occupies a narrow strip along the Oley-Exeter line to the west branch of the Lime Kiln creek, where it swings abruptly W. S. W. with the limestone towards the Schuylkill.

Such is an imperfect general description of the Oley valley, by all odds the richest and most important agricultural township in the mountain district.

There are many small quarries opened in it, and the most important of them were sampled and analysed.

The limestone is generally blue in color, and varies greatly through all grades, from a nearly pure limestone containing 97% $CaCo_3$ and 1.5% $MgCo_3$ to a dolomite or magnesian limestone with a percentage of 41.8 $MgCo_3$ and only 53% $CaCo_3$.

Of course much of this variation in analysis is due to the difficulty of obtaining good average samples, for not only do the individual beds vary greatly in their composition, but so also do the quarries, as a whole, vary from time to time as they are worked.

However, these analyses will serve to locate the good qualities of stone where found, and probably awaken some little interest and energy in a branch of industry hardly born yet in this valley.

The first important outcrop proceeding from Earlville up the Manatawny creek, is in the old *Boyer quarries*, now owned by H. Keefer, located on the east bank of the creek and just north of the Reading road.

The limestone is exposed almost continuously along the creek and Spangsville road to the saw-mill, showing first on the Reading road just west of the old octagonal schoolhouse dipping S. 50° W. 42°.

It is here very cherty and broken up and shows about 40 feet thickness of rock. The dip at junction of Spangsville road is S. 52° W. 30°. Proceeding up creek there is a ledge exposed on creek bank, dip S. 50° W. 28°, which is opened 150 feet further north in a double quarry, exposing about 150 feet of blue and white magnesian limestone, occasionally carrying quartz veins. The quarry is opened in side hill and shows a vertical height of 30 feet of limestone, dipping in the south end S. 40° W. 30°, and in the north end at top of quarry S. 30° W. 20° and S. 50° W. 40°. The limestone is burned in kiln at quarry and shows the following analysis by McCreath:

Carbonate of lime,	53.392
Carbonate of magnesia,	41.848
Oxide of iron and alumina,	1.090
Silicious matter,	3.600
Total,	99.930

It is generally massive, and shows but little slate or top drift, and is easily quarried.

The quarry is generally actively worked. On top of bank, near and south of road up Powder Mill valley there are frequent small exposures of limestone, showing dips of S. 30° W. 30° and S. 10° E. 40° at road, the latter rather slaty.

There are also two exposures on west side of creek, 400 feet north of saw-mill, the first one dipping N. 78° W. 30°, 12 feet thick, and the second one at cove dividing Nos. I and II, N. 75° W. 25°.

Both show hard blue massive limestone and are on north side of Fancy Hill anticlinal.

The next opening is at *Mathias Mengle's quarry* on Powder Mill creek, 800 feet east of road. The dip here is S. 80° W. 20°, and shows about 30 feet of blue magnesian limestone, covered by about 10 feet yellow clay. The following is McCreath's analysis:

Carbonate of lime,	52.357
Carbonate of magnesia,	40.363
Oxide of iron and alumina,	.550
Silicious matter,	6.420
Phosphorus,	.006
	99.696

This limestone is well liked by the farmers and is actively quarried, though as yet the opening is but slightly developed.

Five hundred feet further east up Powder Mill creek or Trout run the junction of Nos. I and II is marked by an outcrop of slaty limestone in creek bed dipping due west 15°.

North from Mengle's quarry the limestone contracts, only occupying the creek bed and a few feet on each bank, between Rabbit hill and Stone Cave hill.

There is a small outcrop in creek bed south of the anticlinal dipping apparently S. 38° E. 15°, succeeded six hundred feet further north by an outcrop of slaty limestone close to the water on west side of creek, dipping N. 20° W. 25°, which is on the north side of Stone Cave hill anticlinal.

From this point the limestone area begins to spread out, until close to small creek heading up behind Rabbit hill, limestone (impure) outcrops S. 60° E. 65°.

Two hundred feet further north, the bluff on west side of creek shows a well defined arch in No. II showing dips of N. 20° W. and S. 20° E. of 60°. This is probably the effect of the dying Sænger's hill anticlinal.

This arch is succeeded in one hundred feet by a dip of S. 20° E. 80° of solid blue limestone twenty feet thick, the south leg of a well marked roll quarried on its north side by *David Davidheiser*, on dips of N. 10° W. 50°–60°.

The limestone is well exposed here, forming a bluff thirty feet high of first class magnesian limestone, about eighty feet thick, and occurring in massive beds.

The following are the results of McCreath's analysis:

Carbonate of lime,	54.267
Carbonate of magnesia,	42.611
Oxide iron and alumina,	.730
Silicious matter,	2.470
Total,	100.078

There are no exposures of limestone along creek from this point until the old Beaver dam is reached, but on small road running up hill from Davidheiser's quarry, there is a small outcrop of limestone near top of hill dipping S. 26° W. 70°. The road is here strewn with mixed boulders of limestone and sandstone, until three hundred feet further south along road a dyke of No. I quartzite strikes across road into Rabbit hill, dipping N. 45° W. 40°. This rock is here a compact fine-grained dark grey quartzite and is evidently a portion of the underlying Stone Cave hill anticlinal, shown here for the last time.

Several outcrops of limestone occur in small hill north of the Beaver dam, and on the road crossing creek.

On this latter, close to J. Penrose's house, two exposures of limestone show dips of S. 40° W. 56° and S. 15° W. 35°, both small and impure.

On the creek to the north the first outcrop dips S. 35° E. 80° succeeded at first bend of creek by a little roll in hill to left with dips of N. 10° E. 30° and S. 10° W. 60°, expos-

ing about twenty feet of good limestone, comparatively free from cleavage. A second similar roll takes place three hundred and fifty feet further north, still on west bank of creek, showing dips of N. 15° E. 50° and S. 10° W. 55°. The arch is wider here, some little distance occurring between these two dips.

The Manatawny here passes over a bed rock of limestone greatly marked with pot-holes all the way up to the iron bridge at Kaufman's place.

The first dip is N. 25° E. 60° just at small island in creek, succeeded two hundred feet north by a dip of N. 50° E. 70° to 80°, in small hill on east bank of creek, limestone here very cherty and broken up into small pieces by cleavage. Two hundred feet further north there is an outcrop in creek bed showing alternate layers of slate and slaty limestone, ribbon marked, dipping N. 50° E. 40°–46°, and finally, just below bridge on east bank of creek, impure limestone dipping N. 30° E. 50°, and marked with strong south cleavage planes. There is a small quarry here and lime-kiln, neither of which show much use.

Between Kaufman's mill and the Furnace creek below Spangsville, the Shenkel's hill axis may exist, for at the latter point and from there north, the dips are all to the west-north-west.

The Potsdam S.S. closes in here to the creek, so that from Spangsville north, all limestone outcrops occur in *west* side of creek.

The small hill at Spangsville is continuously exposed from the road crossing at Furnace creek to within a short distance of the road to the Oley churches.

The limestone is inclined to be slaty and shows a general S. 50° E. 70° cleavage dip, splitting it up greatly.

It is moreover very hard and silicious, and of doubtful quality for burning with advantage. Beginning on the south, the first dip in the creek bed at the ford is N. 40° W. 30°.

Back of the mill these outcrops occur along roadside, respectively N. 32° W. 20°, N. 50° W. 20° white limestone

with marked cleavage, and N. 48° W. 28°, slaty blue limestone.

North of the Spangsville store there is an exposure for about 30 feet along road, overlaid by slate and dipping N. 80° W. 20°, and 300 feet further on greyish white limestone dipping N. 70° W. 30° and apparently showing *north-east* cleavage with a dip of 80°.

Between this knob of limestone and the one mentioned south of Kaufman's mill, there are several small openings on Yellow House-Pleasantville road, close to the toll-gate.

G. Keefer's small quarry is on east side of road and shows a slight roll in good limestone with dips of N. 10° E. 65° and S. 30° E. 55° ; the quarry on west side of road is on the Kaufman estate and shows a dip of S. 50° E. 55°.

Both these quarries are small abandoned test holes, in which the limestone is hardly uncovered.

The next exposure of limestone is on the Oley pike north of the school-house, above the Oley churches, where in road-cut about 30 feet of slaty limestone is exposed, dipping S. 10° E. 65°, greatly crushed and even overturned at its southern end.

Half mile further north on pike there is a small abandoned quarry on west side of road, showing about 10 feet of silicious limestone banded blue and white, dipping N. 35° W. 80°.

Crossing the Little Manatawny at the toll-gate the only exposure along the pike between the creek and the limit of the limestone on the north, occurs in *David Yoder's* quarry about 500 yards north-east of Pleasantville, which shows about 30 feet of excellent blue and white limestone, with some slightly silicious beds, but mostly a soft blue stone carrying calcite. The quarry has been considerably developed, and as it has little or no top soil it can be easily worked. The dips are all to the west as follows:

In the north end S. 60° W. 70° ; in the south end N. 67° W. 63° ; west end N. 60° W. 40°, showing therefore some little irregularity of bedding. An average sample from different parts of the quarry, sampled from quarried stone, shows the following results, (McCreath :)

Carbonate of lime,	91.964
Carbonate of magnesia,	2.337
Oxide of iron and alumina,	.180
Silicious matter,	5.910
Total,	100.391

Ascending the Pine creek from the toll-gate on the Oley pike the first outcrop occurs on west bank of creek about 850 feet west from bridge, dipping N. 57° W. 65°.

Three hundred yards further on there is a small quarry on same side of creek, opened by *Reuben Shearer*, about 10 feet deep, exposing grey massive limestone, dipping N. 50° W. 36°, succeeded in 200 feet by an outcrop of quartzose and slaty limestone, with strong south-east cleavage, dipping N. 84° W. 34°.

Two hundred yards further on the creek forks, receiving the waters of Pine creek, along whose tributaries frequent outcrops of limestone occur. The first of these is in *Wilman's quarry* midway between Connard's paper-mill and Pleasantville, which, though but slightly developed for private use, shows some of the best stone in the township. There is a little slate bedding in the east end but elsewhere the stone is a smooth fine-grained blue limestone, massive, and about 20 feet thick. It has little or no top covering and is readily quarried. The dip is S. 12° W. 54°. McCreath's analysis shows:

Carbonate of lime,	95.125
Carbonate of magnesia,	1.036
Oxide of iron and alumina,	.210
Silicious matter,	3.680
Total,	100.051

The next occurs in *D. M. Schollenberger's* quarry, at base of main hill to east of creek, about ½ mile N. W. Pleasantville. This quarry is but slightly developed, but shows about 12 feet of blue, grey and white banded magnesian limestone, giving the following results on analysis by McCreath:

Carbonate of lime,	59.875
Carbonate of magnesia,	36.024
Oxide of iron and alumina,	1.660

Phosphorus,	.009
Silicious matter,	2.760
Total,	100.328

At north end of this same hill, about 1 mile south of Lobachsville, the limestone is again exposed in *William Weidner's quarry*, where it is rather more silicious and of a darker blue color.

The outcrop is probably 18 feet thick and shows beds of intercalated limestone slate, from 2 to 8 inches thick, con formable with the limestone. The dips are S. 80° W. 35° to 40°.

The limestone beds are of very fair quality, though quartzose, and show the following analysis, (McCreath:)

Carbonate of lime,	66.535
Carbonate of magnesia,	21.645
Oxide of iron and alumina,	1.940
Silicious matter,	9.630
	99.750

The analysis of these two last samples taken from quarries only 500 yards apart, show very plainly the varying nature of the several constituents of these magnesian limestones.

About half mile west of the last locality there is a patch of limestone in small hill along south side of road between Brumbach's and Peter's mills.

On roadside just below first-named mill there is a small opening in black slate (probably No. I) dipping N. 65° W. 10°, succeeded in a few feet by No. II limestone, which 400 yards further N. W. along road is opened by *Isaac Brumbach*, showing dips of S. 10° W. 60° near the road and S. 25° W. 64° further in the quarry.

These dips however are only approximations, as the limestone is greatly jointed by S. E. cleavage planes.

The quarry has been long abandoned and is grass grown.

The limestone exposed measures about 20 feet, blue and gray, and apparently of good quality as far as could be judged.

No analysis was taken at this quarry, nor at the small

quarry or pit 200 yards further north-west along south side of road, owned by the same party.

On entering this quarry from the road there is first an outcrop of dark gray slate, dipping S. 22° W. 50° on west side.

On opposite side of quarry there is a small roll in the limestone with dips of N. 15° E. 50° and S. 5° W. 40°.

The limestone, though only slightly exposed, was cherty and slaty.

Another isolated patch of limestone occurs across the Oley line, in Pike township, separated by a belt of Potsdam sandstone 500 yards wide north of Peter's mill, and lying up against the gneiss of Angstadt hill.

It is opened in two places, on the public road and on the north-west side of knoll.

Neither of these quarries were being worked at time of visiting them, (June 19, '82,) but No. 1 quarry on road showed about 40 feet exposure along road, though only about 10 feet thick; good blue stone at bottom but slaty at top, and with the whole hill for top covering.

The dip is obscure here, but probably S. 4° E. 54°.

No. 2 quarry, in field off road, shows 25 feet of bluish-gray limestone interstratified with bands of slate, the whole marked with *north-west* cleavage and dipping S. 28° E. 40°. Both quarries are owned by J. Keim.

John Keim's No. 2 quarry was analysed by McCreath, with the following result:

Carbonate of lime,	79.107
Carbonate of magnesia,	14.227
Oxide of iron and alumina,	.520
Phosphorus,	.003
Silicious matter,	5.690
	99.547

Returning to Connard's paper mill and ascending small stream heading up to Yoder's spring on the west, about 800 feet west of dam and near bend of road, limestone outcrops in creek bed S. 75° W. 46°, and 200 feet further on, just *at* bend of road, the dip is N. 65° W. 50.

Both outcrops are small, and show inferior stone.

A short distance north-west, on south side of road, there is a small quarry opened by T. P. Lee.

The limestone is blue in color, and in the exposure, largely mixed with quartz veins. Some quartz crystals with good terminations have been found here.

The dip is S. 85° W. 35°; thickness 10 ± feet.

A small outcrop of silicious limestone occurs in roadside just below E. Levan's house, dipping S. 70° E. 30°

West of Mr. Levan's house there is an abandoned and filled-up quarry in which no stone was visible, and 200 yards N. W. at cross-roads to Peter's Mill and Friedensburg there is another quarry, formerly worked, I believe, by Ezra Levan, but known now as

Deisher's quarry.—It shows about 20 feet of blue and white limestone of excellent quality and massive character, *overlaid* by about 2 feet of slate, conformably with limestone, and dipping N. 74° W. 32°.

The following is McCreath's analysis:

Carbonate of lime,	87.642
Carbonate of magnesia,	9.837
Oxide of iron and alumina,	.570
Silicious matter,	2.240
Total,	100.289

This quarry is situated right at the junction of the limestones with the slate, the latter spreading all over the hill to the north-west of quarry.

In addition to dipping north-west *under* this slate, the limestone in Deisher's quarry is actually *overlaid* by two feet of the same slate, all of which is evidence towards proving the slate of this entire hill No. III.

Additional structural evidence of the same character is obtained further up creek, the limestone at Deisher's quarry contracting to a narrow zone on the west side of the creek, and dipping in abandoned quarry north of D. Heckman's house S. 40° W. 40° *into* hill.

Again at head waters of creek, close to roadside in an abandoned quarry, limestone again dips *towards* hill S. 30° E. 38°.

On the other hand, the slate hill itself seems to show an

anticlinal structure, throwing off north-east and south-east dips, so cut up with cleavage planes, however, as to make them at least doubtful.

A similar occurrence takes place on the west bank of the Furnace creek in *J. G. Bertolet's quarry* and the succeeding limestone outcrops.

Here in a double quarry, close to the road bend, an excellent quality of stone has been opened, about twelve feet thick, showing dips in east end of S. 78° W. 38°; in centre S. 85° W. 35° and at west end S. 60° W. 35°—all *toward* the long slate ridge extending from Glase's mill on the north to the Little Manatawny on the south.

The analysis of the blue and white soft stone (McCreath) shows:

Carbonate of lime,	92.214
Carbonate of magnesia,	4.986
Oxide of iron and alumina,	.420
Silicious matter,	2.750
Total,	100.370

A short distance up creek from this quarry there is another small opening in side hill close to the slate that comes in from above top of quarry, the limestone dipping here apparently N. 52° W. 38°. One hundred feet further north the limestone dips directly into hill S. 48° W. 40°, while at an equal distance again an impure slaty variety dips N. 20° W. 30°. Between all these outcrops the limestone is greatly twisted and contorted and though frequently exposed in the side hill its true dip is hard to determine.

The limit of the limestone on Furnace creek is about five hundred yards north-west of last named outcrop, where it comes to a point on the creek just south of Weiser's saw mill.

On Little Manatawny creek, south of Bertolet's steam mill, a narrow strip of limestone extends through the two slate hills shown there, which on road close to the bridge dips likewise into hill at an angle of 20°–52° S. 40° E.

The limestone is here very slaty and is overlaid by a grey talcose slate, outcropping at several places along hillside

and forming the greater part of this slate ridge south-west to Weaver's mine.

Returning down creek towards mouth, limestone outcrops in creek bed, close to D. F. Bertolet's house; dip obscure, but probably N. 80° W. 30°.

Up small ravine south from this point *Mr. D. F. Bertolet* has opened limestone in the side hill. There is probably forty feet of blue banded and massive quartzose limestone exposed here, the quarry showing a perpendicular face against hill of thirty feet and a dip of S. 20° W. 60°. The quarry was not being worked at time of visit and was not sampled.

Further down creek near road bridge limestone outcrops in creek bed dipping N. 50° W. 35°.

On crest of small hill south of the Little Manatawny, limestone again outcrops on road to the Oley churches, dipping about N. 75° W. 30°, and again in field just west of this in a small quarry—no dip.

The road from Friedensburg to the Oley pike shows exposures of limestone first about two thousand feet south-east of Bertolet's mill, dipping S. 50° E. 38°, hard silicious white limestone; again on north side of road in a new quarry opened on the *F. V. Kauffman settlement*, where a rather slaty variety dips N. 84° W. 38°.

The quarry is capable of easy development and shows good stone beneath the slate.

Its analysis by McCreath gave the following result:

Carbonate of lime,	63.107
Carbonate of magnesia,	27.402
Oxide of iron and alumina,	1.450
Silicious matter,	8.210
Total,	100.169

Four hundred yards further south-east and on south side of small creek heading up here from Griesermersville, another and older quarry has been opened by Kaufman, where about twenty-five feet of hard blue magnesian limestone is exposed dipping N. 83° W. 32.

The remaining exposures of limestone in the Oley valley

south of the Friedensburg-Oley churches road and west of the Oley churches-Yellow House road are as follows, beginning in the neighborhood of Griesermersville:

L. De Turk's quarries, the first or most northern quarry being situated about three fourths mile north-west of Griesermersville on left bank of small branch to Manatawny creek, entering south of Spangsville, and about two hundred yards north of De Turk's house, which shows about twelve feet of brecciated limestone dipping S. 60 W. 30°.

The second, or southern quarry, is located on private road three hundred and twenty-five feet in from Friedensburg—Yellow House road, considerably developed, though idle when visited.

There is about twenty feet of good blue and white banded magnesian limestone exposed here, dipping S. 18° W. 55°.

On public road north-west of this latter quarry there are two outcrops of blue limestone, the first in *Ellis Winter's* small quarry, on west side of road, fifteen feet of splendid dark blue soft limestone, with about four feet of yellow clay top—dipping S. 30° W. 55°; and second, a small outcrop on road dipping S. 10° W. 50°.

The stone in Ellis Winter's quarry is among the best in the township, as the following analysis by McCreath will show:

Carbonate of lime,	96.178
Carbonate of magnesia,	2.176
Oxide of iron and alumina,	.290
Silicious matter,	1.750
Total,	100.394

Three thousand feet north-west along road there are two more small openings, close to the base of the slate hill, the first on west side of road exposed in *S. Houck's quarry*, showing ten feet of good blue and white stone, dip S. 60° W. 38°.

The following is Mr. McCreath's analysis:

Carbonate of lime,	88.857
Carbonate of magnesia,	3.783
Oxide of iron and alumina,	.310
Silicious matter,	6.800
Total,	99.750

The second, in *Peter Guldin's* quarry on east side of road; dip S. 60° W. 40°, fifteen feet exposure.

Limestone also outcrops on road between these quarries just at lime-kiln, dip S. 58° W. 43°.

Half mile west of Griesermersville, and just south of the Oley pike, a new opening has been made by Levi Hartman, exposing about eighteen feet of good blue and white stone, dip N. 10 W. 64°.

Between Griesermersville and the toll-gate and south of the Oley pike there is a small limestone pit, no dip

Three quarters of a mile S. W. of Griesermersville, limestone is exposed east of smith shop dipping S. 60° W. 32°, cherty and very much broken up.

Further south 500 yards on Yellow House road, silicious limestone again shows, dipping S. 72° W. 25°, succeeded 400 feet south, near summit of small hill, by two outcrops showing a local roll in limestone, dipping N. 75° E. 50° and S. 70° W. 42°; and again, south-west of this last place 300 feet in field, dipping N. 70° W. 70°.

Midway between this and the Yellow House a small quarry has been opened on west side of road, near base of hill, on *S. P. Guldin's* estate, showing 20 feet of first-rate blue quartzose limestone, dipping into hill N. 50° W. 40°.

McCreath's analysis of the quarry shows:

Carbonate of lime,	90.357
Carbonate of magnesia,	2.800
Oxide of iron and alumina,	.310
Silicious matter,	6.640
Total,	100.107

The small creek south of this quarry, at forks of road to Friedensburg and Pleasantville, divides the limestones from the slate ridge on the south, and north of this on the Pleasantville road several outcrops of limestone occur.

The first of these, on small summit, dips N. 86° E. 65°; the second, 150 feet further north, S. 75° E. 55°, and the third, 200 feet further on, S. 35° E. 78°.

In field to left of road above this last outcrop limestone has been opened in *E. Schaeffer's quarry*, exposing about

30 feet of blue limestone capped with 3 feet of slate, and dipping N. 78°–88° W. 35°–37°.

A last outcrop occurs on Pleasantville road just at Rhoads' house, south of small creek, dipping N. 80° E. 40°.

The rest of Oley township between the Yellow House—Friedensburg road, and the Oley-Exeter township line road, is a mixed area of limestone and slate, about equally divided, the limestone running up the numerous small coves formed by the creek's traversing the slate ridges.

Beginning on the north, the first outcrops of limestone occur east of Hunter's hematite mine, on the old Kemp farm.

In the small quarry there blue limestone 6 to 10 feet thick outcrops, dipping S. 60° W. 20°, succeeded nearer to the mine by an exposure in field dipping S. 48° W. 22°.

Going south from the mine limestone is again exposed in *Col. J. Weaver's quarry*, on west side of road, showing about 10 feet of massive blue dolomite but slightly developed, dipping N. 65° W. 12°.

The following are McCreath's results:

Carbonate of lime,	71.178
Carbonate of magnesia,	23.263
Oxide of iron and alumina,	1.080
Phosphorus,	.005
Silicious matter,	4.770
Total,	100.296

Five hundred yards south of this quarry and about 200 yards in east from road at base of hill, *Seth Grim* has opened a small quarry, in excellent compact massive limestone, soft blue and white, 15 to 20 feet thick. Dip was obscure here, but is probably north-west. McCreath's analysis shows the good character of the stone here:

Carbonate of lime,	96.667
Carbonate of magnesia,	2.081
Oxide of iron and alumina,	.350
Silicious matter,	1.010
Total,	100.108

As exposed, it shows some of the best stone in the town-

ship and deserves more systematic working, being remarkably free from quartz and impurities.

D. Kemmerer has opened two quarries on either side of the road, in the same range of limestone, which here is of rather a more pronounced blue, but of equal freedom from impurities.

The quarry on west side of road at lime-kiln, close to slate hill, shows about 15 feet of compact blue limestone, dipping *into* hill S. 70° W. 10°, overlaid by about 4 feet of conformable slate.

There is a unique wood-burning kiln here upon which Mr. Kemmerer spent considerable thought and money with an idea of improving draught.

It is made of brick about 25' high, cylindrical in shape, banded on top with an iron ring. Spliced into the brick walls with iron L-shaped guides, there is a sheet-iron chimney 3' 6'' high, also cylindrical, and with the same circumference as the kiln.

The upper part of this chimney—also about 3' 6'' high—is cone-shaped, its sides sloping on top to a width of about 3'. From this rises a 25' stack of sheet-iron, 3 feet in diameter, devised to increase the draught.

The lower part of chimney is provided with 4 curved doors and which open out and rest on the L-shaped bars through which the charge is made.

Neither kiln or quarry were being worked at time of visit, so that no practical results can be reported.

The analysis of this stone by McCreath is as follows:

Carbonate of lime,	95.500
Carbonate of magnesia,	2.724
Oxide of iron and alumina,	.230
Silicious matter,	1.940
Total,	100.394

A small opening north of this quarry shows same limestone dipping into hill S. 72° W. 8°, and a larger opening to south, near creek and at base of hill, where the stone is harder and more compact, dipping S. 48° W. 16°.

On the east side of road a new opening has been made by same party, in light blue rather silicious limestone, 15 feet

thick with six feet top soil, abandoned and grass grown, showing dip of N. 10° W. 18°.

Six hundred yards along road towards Oley Line hotel, north of creek crossing, limestone outcrops on roadside above house dipping N. 10° W. 40°.

Three thousand feet west of this, and in against slate hill, *P. Sneider* has made several openings. His upper quarry, to east of small lane leading over slate hill, exposes 30 feet of hard blue limestone of excellent quality dipping at west end of quarry N. 65° W. 30° and overlaid with slate.

The east end of the quarry shows a slaty variety with dip of S. 45° W. 48°, succeeded further east between main quarry and small opening by quartzose limestone, blue, dipping N. 80° W. 26°.

The small quarry furthest east shows stone of same quality. The dip here is N. 82° W. 30°.

An average sample of this stone shows the following analysis (McCreath:)

Carbonate of lime,	97.321
Carbonate of magnesia,	1.496
Oxide of iron and alumina,	.210
Silicious matter,	1.320
Total,	100.347

On public road just south of this locality and east of dwelling, another quarry has been opened by same party, but the limestone is not as good and is broken up with south-east cleavage planes dipping 80°. The dip of the limestone, here about twenty feet thick, is N. 77° W. 30°.

On the Oley pike, south-east of Sneider's quarries, and on small hill eight hundred feet east of Lime-kiln creek crossing, there is an exposure of limestone in roadside, dipping S. 22° E. 55°, and about same distance west of same creek on road, another exposure on road dipping S. 15° E. 42°. An excellent quality of limestone, blue and white, is opened in *D. Hine's* small quarry, seven hundred feet further west, dipping S. 20° E. 33°. This quarry is only worked for private use on the farm but the stone is massive and pure.

Due south five hundred yards, close to slate hill, and

dipping again *under* the overlying slates, *Levi Knabb* has opened a small quarry in good blue soft limestone. The dip here is S. 32° W. 30°–38°.

A second exposure just north of the quarry and close to the road leading over slate hill to the Oley-Exeter road, shows a dip of S. 35° W. 27°.

Two hundred yards further south, along road to Yellow House, the dip in road is S. 14° W. 36°.

Various small exposures occur along the road to Lime-kiln creek where the dip is S. 30° W. 28°.

Crossing creek, limestone is again exposed at Raudenbusch's mill in road dipping S. 17° E. 20°, and on south side of creek, in hill, finely exposed twenty-five feet thick in *Raudenbusch's quarries*, dipping due south 25°–30°. The limestone is magnesian, generally white to dove color, and greatly broken up and seamed with quartz, making it siliceous and of poor quality.

The following is McCreath's analysis :

Carbonate of lime,	51.303
Carbonate of magnesia,	32.713
Oxide of iron and alumina,	1.060
Silicious matter,	15.220
Total,	100.296

One hundred and fifty yards further east, just at bend of road, a more compact limestone is exposed dipping S. 45° W. 30°.

North-east of this locality five hundred yards, on private lane, *Ezra Griesermer* has opened a quarry in excellent blue and white compact limestone, twenty-two feet thick, dipping S. 60° W. 12°, breaking in large slabs good for foundation walls.

McCreath's analysis is as follows:

Carbonate of lime,	92.142
Carbonate of magnesia,	1.832
Oxide of iron and alumina,	.560
Silicious matter,	5.830
Total,	100.364

The next opening is about one half mile due south, just north of slate ridge, where *J. G. Fischer* has opened three

small quarries, all showing excellent soft blue stone, burnt on the ground at his own kiln. The dips are all *towards* the hill as follows: S. 63° W. 20°, fifteen feet thick, in east quarry; S. 75° W. 25°, thirty feet thick, in middle quarry with ten feet of slaty top covering; S. 65 N. 24°, twenty-five feet thick in west quarry, six feet of slate top. Samples were taken from all these quarries, which are on the same outcrop, and the combined result forwarded to McCreath, who reports the following percentages:

Carbonate of lime,	95.575
Carbonate of magnesia,	1.535
Oxide of iron and alumina,	280
Silicious matter,	2.950
Total,	100.340

On south side of slate hill, and close to road leading down creek, *Levi Herbein* has opened a quarry in same stone. It was abandoned and partly closed up, but is said to have lead into a cave in its west end, where some fine stalactites were found. The cave was explored for 125 feet —all in good blue limestone. The general dip was S. 50 W. 33°, and McCreath's analysis:

Carbonate of lime,	90.214
Carbonate of magnesia,	6.420
Oxide of iron and alumina,	210
Silicious matter,	3.500
Total,	100.344

A bastard slaty limestone is exposed further along this road, near L. J. Bertolet's house, in roadside, dipping S. 40° W. 42°.

The hill to east of this and the creek, as far up as the cove dividing it from the slate ridge just mentioned, is composed of the same bastard limestone, so slaty sometimes as to make it difficult what to name it.

On the Reading road to south, in Amity township, about ½ mile west from Yellow House, and close to the junction of New Red, a hard, white silicious limestone outcrops, so broken with small cherty masses as to obscure the dip. It has been burned, however, in a kiln there, but with little evident success.

Following along the Oley-Exeter township road from here, which passes over the conglomerate measures of the Mesozoic formation between the two branches of the Limekiln creek, limestone is exposed in hill on east side of west branch Limekiln creek, low down in valley, dipping S. 20° E. 30°, blue in color, and of good quality. Four hundred feet north along valley, and on same side of creek, a small abandoned quarry is located, on land of L. J. Bertolet (?), exposing about 10 feet of good compact limestone, dipping S. 30° E. 40°.

The quarry was formerly owned by *Samuel Marquart*, and shows the following constituents by McCreath's analysis:

Carbonate of lime,	81.286
Carbonate of magnesia,	10.412
Oxide of iron and alumina,	.870
Silicious matter,	7.820
Total,	100.388

Proceeding towards Oley Line hotel, limestone outcrops on road just at top of small summit; dip obscure, but apparently S. 45° E. 10°–15°.

In field about 400 yards west of this point a quarry has been opened in limestone, which shows excessive cleavage and conceals dip.

In the east end of the quarry—now abandoned—there is about 12 feet of limestone overlaid with slate, which apparently dips S. 75° W. 10° (?) whilst in the north end, back of kiln, the dip seems to be S. 30° E. 40°. The latter is probably the more correct dip.

There is another quarry of considerable size, a little further west of this, whose sides are all covered up with limestone-clay, and quartz particles, where no outcrop is visible.

To the north of these quarries on same road leading over slate hills to Knabb's quarry, the limestone outcrops in a small exposure, dipping S. 40° W. 30°.

North of the junction of this road with the township line, limestone has been slightly quarried by *John Snyder*.

The limestone here is rather silicious but otherwise of a good quality and shows about 25 feet exposure, dipping in

the south quarry near small road S. 36° W. 55° where it is hard and blue.

Above this there is a band of bluish white stone 5 feet thick, dipping at north end of same quarry S. 10° E. 15°.

Between this quarry and the small one joining it on the north, the limestone is greatly twisted and metamorphosed, probably somewhat influenced by the trap dyke occurring in Kaufman's quarry on Monocacy Creek to be afterwards mentioned. The dip appears to be S. 15° E. 50° and the outcrop is partly shaly.

An analysis of this banded limestone gives the following result (McCreath) :

Carbonate of lime,	89.214
Carbonate of magnesia,	2.714
Oxide iron and alumina,	.520
Silicious matter,	7.890
	100.338

The road from here to Oley Line hotel shows a considerable number of trap boulders, but no dyke was visible on the surface.

Near Mr. Snyder's house limestone outcrops twice on road, dipping S. 56° W. 40° and S. 40° W. 30°, blue and rather slaty.

East of the hotel 200 feet, on the Oley pike, a silicious variety of limestone is exposed dipping S. 50° E. 30°.

Going north about 200 feet from hotel along township road, a pure white silicious limestone outcrops dipping S. 10° W. 20°; and again about 200 feet northwest of bridge over Monocacy creek dipping S. 15° W. 20° in two outcrops on the road.

Two hundred yards further on, in Exeter township on west side of road, *Albert Knabb* has opened a quarry in blue and white magnesian limestone in small knoll close to the gneiss hill.

There is about 30 feet of limestone here, cut up with nearly vertical cleavage planes, the limestone itself showing a slight anticlinal roll in south end of quarry dipping N. 30° W. 30° and S. 20° E. 20°.

The following is McCreath's analysis of this stone :

Carbonate of lime,	60.089
Carbonate of magnesia,	38.185
Oxide of iron and alumina,	.230
Silicious matter,	1.290
Total,	99.794

A couple of hundred yards north of this quarry the limit of the limestone is reached just north of A. Knabb's house, though it swings around the hill there, and extends a short distance up the Monocacy and branches, reaching as far north on the main creek as Nathan Knabb's house.

This about completes the limestones of Oley township, the belt near the Oley Line hotel becoming greatly contracted, and pursuing its course west through Exeter township to the Schuylkill.

Before leaving the township it may be well to say a few words concerning the character and outcrops of the

Oley Valley Slates.

Dismissing the question of their age, which for reasons already given page 47, apparently admits of their being variously No. I and No. III, their development in Oley township is in three well-defined groups, whose boundaries have been pretty well described in noting the limits of the limestones.

The first group occurs in the north part of the township represented in two patches, the first one *entirely* surrounded by limestone and occupying a portion of the summit and south flank of small hill just west of Pine creek and about 1¼ miles N. W. of Pleasantville on the road to Friedensburg.

But one dip is exposed here, and that occurs in such broken slate as to render its correct interpretation difficult.

The exposure is on small lane 150′ in from main road, and shows a black gritty slate with an apparent dip of N. 44° E. 82°.

Frequent masses of bluish black and brownish fissile slate cover this hillside and the roads in places, notably near Keim's cemetery and limekiln on road to Lobachsville; but nowhere else does it occur in place.

The second portion of this northern or first range of slate is represented in the hill about 1¼ miles N. E. of Friedensburg, where it occupies a considerable area, bounded on the north by the narrow tongue of limestone on south side of branch to Pine Creek, between Deisher's quarry and the road from Yoder's place to Friedensburg. On the west and south loose Potsdam sandstone boulders everywhere cover the flat country, the slate being confined to the hill and north of the small stream heading up from D. F. Bertolet's place on the Little Manatawny. Its east boundary is the Oley valley limestones of No. II.

The dip in this slate ridge favors its being an anticlinal, but cleavage here again is a great obstacle to correct interpretation.

On the road between Deisher's quarry and D. Heckman's house, and about 200 feet N. W. of limestone quarry, the slate outcrops, strongly marked with cleavage dip of S. 37° E. 45°, though probably dipping N. 45° E. 40°.

It is very much broken and of a gray color, flaky and jointed. A better exposure takes place on both sides of cove at J. Heffner's place, 300 yards further on, where for 30 feet on each side of cove the slates are exposed along roadside, greatly twisted and broken, and here of a rather reddish color.

The cleavage is all to the S. E., but the dip is probably from N. 50°–70° E. 25°–40°, dipping *towards* stream, and consequently *unconformable* with the limestones.

On road leading S. W. from Heckman's house over hill, and close to summit, slate again outcrops, dipping N. 40° E. 50°, showing as usual but little firm bedding and of a more talcose character.

On south flank of hill, close to creek and just north of DeTurk's house, slate shows in roadbed, dipping S. 40° W. 25°, and again further north on Pleasantville road S. 2° W. 20°. Both these outcrops show light-colored slate accompanied with quartz pebbles—generally covering the entire south-west flank of hill—sometimes accompanied with Potsdam sandstone boulders of small size.

The second range of slate is divided from the first by the

Potsdam sandstone area about ½ mile wide before mentioned, which extends as far south as the Furnace creek, south of which is the slate.

The latter forms a long ridge about 1¾ miles long and ¼ mile wide, extending from Glase's mill on the N. W., to the Little Manatawny, surrounded on three sides by Potsdam sandstone soil and boulders, and on the fourth or east by the limestone of No. II.

No slate seems to exist *south* of the Friedensburg-Oley church road, unless in a very much decomposed condition, though frequent outcrops of it are seen *along* that road whose decomposition makes a well packed road bed.

The slate is generally of a light color and stained red with iron, accompanied with the same excessive cleavage before mentioned.

On top of hill near school-house, on road running N. E. out of Friedensburg to Yoder's house, two crushed and broken exposures are seen in road bed, the first one dipping N. 14° E. 85°, and showing a tendency to fall over to the south-east; the second just opposite the school-house, dipping apparently S. 10° E. 75°, underlaid with broken quartz rock.

On north flank of hill, and in road crossing from Oley Academy, there are two exposures, the more southern being S. 10° E. 70° (probably cleavage) and the other S. 30° E. 55°. Neither of these is reliable, as the whole outcrop, probably 25′ thick, shows every conceivable contortion.

On the Friedensburg road northwest of Colonel Weaver's house slate is exposed dipping S. 50° E. 10°.

Again, just below the Union Church S. 40° E. 12° and close to road at base of hill S. 42° E. 22°.

All these may be cleavage and the *true* dip a north-east one into hill.

The slate covers the hillside and road in a profusion of reddish scales and probably belongs to No. 1.

It is again finely opened in *Israel Bertolet's* quarry at base of hill on Furnace creek, exposed in the face of the quarry for about 30 feet and dipping S. 68–74 E. 35–45°.

It here consists of a greenish-grey, dark slate overlaid by

a softer and brownish talcose species. It sells for about $2 50 per cord, and is extensively used in the neighborhood for lining limekilns.

The Little Manatawny, carrying a narrow strip of limestone, divides this ridge from the patch of slate extending over hill from the mill to Weaver's Mine.

Close to the creek and road bridge it shows an outcrop of slate and slaty limestone dipping into hill S. 40° E. 20°–52°, and at bend of road at J. Weaver's house, a compact grey slate, differing greatly from the Friedensburg ridge outcrops, and dipping S. 40° W. 40°.

The slate in this hill is probably No. III, and plays an important part in the Weaver mine, occupying fully one half of the open cut, and furnishing a good clay for the manufacture of building brick.

The third and last range of slate is the most southern as well as the most extensive, occupying a considerable part of the west and south parts of the township, and represented in a crescent shaped chain of hills averaging 400 feet above ocean level, extending from the cove 600 yards south of Kaufman's mill on the north, to the Yellow House, generally swinging around to the east with the Oley-Exeter township road, and cut up with frequent limestone areas spreading into them like fingers along the numerous small water courses.

They can be described as a whole as being of much lighter color and firmer texture than the slate of the other ranges; carrying frequently threads of quartz; and variously interstratified with the limestones near the line of junction.

Though generally accompanied on all sides by limestone, the Monocacy creek, from J. Knabb's to the old brick oven south of Kaufman's mill, divides it from the white Potsdam sandstone, here present however, only as boulders. All attempts to carry the limestone north from N. Knabb's place along the Monocacy to join the area south of Friedensburg failed—whether from its non-existence there, or because the mixture of decomposed slate and sandstone prevented its recognition. A small offshoot of the Monocacy near J. Knabb's place marks the south limit of the sand-

stone, the soil to the south of it being everywhere slate and marked by a freedom from Potsdam boulders. As far south as Albert Knabb's place the slate everywhere lies against the gneiss rocks.

But few outcrops take place throughout this range of hills, owing to the ready decomposition of the slate, and the generally cultivated character of the country.

On Levi Merkel's farm, on the road leading over the north portion of the range to Friedensburg, slate shows in road bed and gutter, dipping S. 25°–45° W. 30°–40°, of a bluish grey color, and carrying quartz threads.

All along this road up hill, and especially on its north flank, large chunks of pure white milky quartz are profusely spread, showing some weathering, and rusty concretions.

Close to the junction of the slate and limestone on north flank of hill, slate outcrops in road gutter, twisted and overturned but probably dipping S. 83° E. 20°.

Balls of yellow ochre are scattered along fields here.

Slate outcrops again near saw mill about ½ mile up Monocacy creek from Oley Line Hotel, dipping S. 25° W. 42° and again along the private road leading from here close to Oley pike, in same hill dip S. 30° W. 40°

This last outcrop is about 20 feet thick, of dark grey slate.

Northeast from Oley Line Hotel, on pike and close to first road to east, slaty limestone outcrops at head of cove, dip S. 10° W. 35°; but 250 yards further along pike, the slate belt crosses the road, and is exposed there in a cut 15 feet deep, showing mostly loose, reddish, flaky slate, with a general dip of S. 40° W. 60°.

On summit 380′ west of C. Herbein's place, slate outcrops, dip S. 32° W. 28°.

Slate is exposed in one other place before the eastern limit of the range is reached. This is on road running along Lime Kiln Creek from Bertolet's to Fischer's house, and shows in slate knob crossed by road just south of Herbein's limestone quarry, dipping S. 40° W. 42°, here light colored and calcareous.

The general outline of the slate in the Oley Valley may

be best obtained from the Index Map, from which as a guide, the atlas sheet XI can be accurately colored by any one who wishes to see the slate areas on a larger scale.

Limestones west of Oley valley.

Returning once more to the limestones and taking up the exposures west of the Oley-Exeter line, *S. Kaufman's quarry* is first in importance.

It is situated on the east bank of the Monocacy in Exeter township, about ½ mile south of the Oley Line hotel.

It shows both good and poor stone, metamorphosed and rendered hard and crystalline near the trap dyke that occurs in the south portion of the quarry, but soft and of firm, fine-grained, massive texture elsewhere.

The dyke is about 6 feet wide, composed of a fine-grained, black trap (basalt.)

This is the only place the trap is exposed, but its existence is marked by an alteration in the limestone all through the hill to the south-east, on west side of creek, as well as by the before-mentioned metamorphism in J. Snyder's quarry on the township line road.

In the centre of Kaufman's quarry the limestone is much twisted, but shows an average dip of N. 30° E. 50° and a blue massive stone of good quality.

The north end of the quarry shows a dip of N. 23° E. 20°; the south end near trap dyke a bed of white, hard bastard limestone, dipping N. 40° E. 30°.

If the dyke has influenced the direction or amount of dip at all it has influenced all parts of the quarry alike, but the texture of the stone *nearest* the dyke is decidedly metamorphosed. There is fully 60 feet of limestone exposed here in a face 30 feet high, and samples from this quarry, which was idle at time of visit, were taken with an idea of getting a general average of the whole quarry, so that no one bed or part of the quarry was analysed separately. McCreath sends the following results:

Carbonate of lime,	80.160
Carbonate of magnesia,	9.459
Oxide of iron and alumina,	.980
Silicious matter,	9.100
Total,	99.699

On opposite side of creek from this quarry, limestone is exposed in a ledge 25 feet thick, rather impure and cherty, dipping N. 21° W. 36°.

Further north, close to pike, on west bank of Monocacy creek, *D. Snyder* has opened a small quarry in hard, blue, silicious limestone, with slaty top, dipping S. 14° E. 12°; again exposed on opposite side of creek, dip S. 35° E. 25°.

South from Kaufman's quarry, on west bank of creek, two outcrops of slaty limestone show in hillside just below farm road, dipping N. 22° W. 38°-40°

West of Marquart's mill there is a small gneiss hill, which has projected over the Oley pike and marks the limit of the Laurentian formation here

No Potsdam intervenes between it and limestone, the latter dipping at its south base S. 25° E. 45°.

Five hundred yards south of this on next hill silicious limestone outcrops on crest, dipping S. 10° E. 42°, and showing metamorphism.

No outcrops occur from here until west of the branch of Spring creek, crossing Oley pike at Charles Breneiser's house, where limestone, silicious in character and of a white color, outcrops in pike, dipping S. 85° E. 30°, rather slaty, and S. 20° E. 15°.

Going in 600′ on private road to Benj. Ritter's place, leaving pike near Spring creek, slaty limestone outcrops in road, dipping S. 32° E. 80°, succeeded at bend of road near his barn by alternate layers of slate and limestone in frequent exposures, dipping N. 42° W. 65°-85°.

Three hundred yards further south-west along his private road limestone again appears, with a dip of 48° S. 42° E.

Mr. Ritter has opened a small quarry in good blue limestone about 800 feet south-west of last locality mentioned, dip S. 87° W. 10°, and as exposed 12 feet thick, in massive beds. McCreath reports the following analysis:

Carbonate of lime,	87.910
Carbonate of magnesia,	7.340
Oxide of iron and alumina,	.370
Silicious matter,	4.590
Total,	100.210

This same limestone has been opened on its outcrop in *Cornelius Tyson's quarry*, 500 yards south-west, where in the east end there is a small anticlinal roll, dipping S. 88° W. 15° and N. 86° E. 10°, and showing rather cherty stone. The dip is S. 85° W. 18° in the west part of the quarry where good blue limestone can be found. Both these last-named quarries are small and but slightly developed, being only worked for private use on the owners' farms. They both, however, should demand more attention from the farmers living in the red sandstone country close by, owing both to their accessibility and the general good quality of the stone.

The following is McCreath's analysis of Tyson's quarry:

Carbonate of lime,	86.889
Carbonate of magnesia,	5.728
Oxide of iron and alumina,	.470
Silicious matter,	7.240
Total,	100.327

There is a small abandoned quarry just at Reading road, close to creek and about 800 yards south-east of Jacksonwald, which shows evidences of a compressed synclinal. An extensive family of hornets were holding a reunion at the time of visit, which prevented too close an inspection of their dwelling.

Several exposures of limestone take place along *Antietam creek* north from Brumbach's wool factory, dipping in private road at base of sandstone hill N. 25° W. 20°, and in quarry on opposite side of creek N. 20° W. 45°.

Thirty feet of good blue limestone is exposed in face of quarry, which, however, was not working, nor could I learn who owned or last worked it.

Near Reading road, 200 feet N. W. from this point, there is another abandoned quarry, the dip being about N. 22° W. 30.°

Following up the *Antietam creek*, limestone is exposed twice on road near Oliver DeHart's place, about 500 yards north of Black Bear Inn, where on summit of small hill it shows a small anticlinal roll, with dips of N. 50° W. 60° and S. 42° E. 75°.

About 800 feet north-east of these outcrops, fine, white, soft limestone is exposed close to creek, near M. Schweitzer's place, dipping N. 60° W. 65°. These are all the exposures east of the Philadelphia pike.

About 1¼ miles S. E. of *Black Bear Inn*, on *west* side of pike, and about 800 feet from the junction of limestone and Mesozoic conglomerate, near F. Esterly's house, a white and rather crystalline limestone is exposed in road cut, grading into slate and gravel, and considerably decomposed. Dip S. 15° W. 70°.

Turning in private road towards railroad, 400 feet south of this outcrop, limestone is again exposed and worked in a small quarry, about 600 feet in from pike. The dip here is S. 12° W. 65°.

The exposure is about 10 feet thick, and shows a gray and white slaty limestone, in places rather unctuous to the touch, and containing considerable quantities, of a dark black mineral, with dull lustre, not unlike graphite. A dull, brown slate accompanies it.

Jonas DeTurk's quarry is situated about ½ mile west from here in the same geological position, close to the Mesozoic Conglomerate, from which it is divided by a small stream. There is a large double opening here of blue stone, which, beneath the covering of 20 feet of slaty limestone, is of good quality, though very much twisted and crushed in places. The dip on top of quarry seemed to be about S. 20° W. 75°. The quarry was idle when visited. It was probably here that the small, flat rhombohedra of calcite were found, with a pale pink or rose color, and which were analysed by Dr. W. J. Hoffman, of Reading, with the following results (Report B., p. 228.)

Specific gravity,	2.79	
Carbonic acid,		41.65
Manganous oxide,		8.20
Ferrous oxide,		trace.
Lime,		44.36
Loss and water,		5.79
Total,		100.00

"It is remarkable for the large quantity of carbonate of manganese which it contains=13.28 per cent."

Five hundred yards west of this quarry, on road to Neversink station, below F. B. DeTurk's house, slaty limestone outcrops dipping S. 2° W. 60°.

The limestone zone is very much contracted here, and extends as a belt 400 feet wide to the river, at the Big Dam limestone quarry, where the limestone is found resting conformably on the Potsdam sandstone, and dipping steeply south-east 60°, under the overlying Mesozoic Conglomerate. A cut of this quarry as it appeared 25 years ago—filled with breccia, and displaying distinct cleavage joints is shown in Fig. 8, page 191, taken from Rogers' Final Report, Vol. II, p. 682.

An analysis of this limestone by McCreath shows:

Carbonate of lime,	67.821
Carbonate of magnesia,	24.025
Oxide of iron and alumina,	1.340
Phosphorus,	.009
Silicious matter,	7.050
Total,	100.245

Fine specimens of calcite (dog-tooth spar) were found here. The quarry is an old one and the stone has been largely burned with the New Red conglomerate, here very calcareous. The face of the quarry shows varying blue and pink beds of compact fine-grained stone.

This limestone is shown at the point of Poplar Neck on west side of river, where it is slightly quarried, dipping under the conglomerate S. 25° E. 50°.

Another limestone area is comprised in the Neversink Hills synclinal, cut through 25 feet by the P. & R. railroad, in the first big bend south of Reading, where it has been considerably altered and metamorphosed by pressure, and shows a crystalline texture. The limestone here is generally white and so contorted and twisted that all attempts to get reliable dips were abandoned.

It was sampled throughout the cut and the results sent to McCreath, who reports the following analysis:

Carbonate of lime,	51.303
Carbonate of magnesia,	37.557
Oxide of iron and alumina,	1.960
Silicious matter,	9.130
Total,	99.950

The western limit of this limestone is represented on the Schuylkill by a strip four hundred feet wide, extending from the cove at the second Wilmington and Northern R. R. bridge, where it is overlaid by the Mesozoic conglomerate, north to the junction of the Potsdam sandstone at small creek below E. High's place. One dip was secured in it, N. 70° E. 50°, where it was exposed in bank close to the New Red, for about 18 feet, showing blue limestone very much twisted; and one dip near the Potsdam junction, where it was rather obscured, but probably N. 5° E. 40°

The whole formation bordering the Schuylkill is covered with flint and sandstone boulders derived from Neversink hills, and has furnished many specimens of Indian antiquities, marking the places of their former villages in the early days of settlement here.

The only remaining limestone *east* of the Schuylkill that comes within the limits of this chapter occurs within the city boundaries of Reading.

Beginning on the east in the narrow trough running along the Perkiomen pike, the most eastern point of the limestone is marked by the 200′ contour line just south of the Mineral Spring road, if I except the small outlying patch of No. II that has been left to mark the former presence of the limestone over the valley of the Antietam creek, represented in the small quarry of silicious limestone on Ohlinger dam road, 400 feet north of Dengler's hotel, which shows a dip of S. 70° E. 46°.

The limestone basin at the north base of the Neversink hills, is about 400 feet wide increasing westward until at St. Paul's Catholic chapel it spreads south as far as the P. & R. pump house, below the Henry Clay Furnace, and north-east around Mt. Penn into the wedge-shaped plat extending up to the Pricetown road, and north-west to join the limestone of the Schuylkill and East Penn valley.

A patch of No. III, Hudson River slate, caps the limestone west of the P. & R. railroad, occupying Cemetery hill, as shown on the Index map. Several exposures of silicious limestone occur along the base of the Neversink hills, the first one in a small pit close to the junction of No.

Fig. 8. Big dam limestone quarry

(H D Rogers)

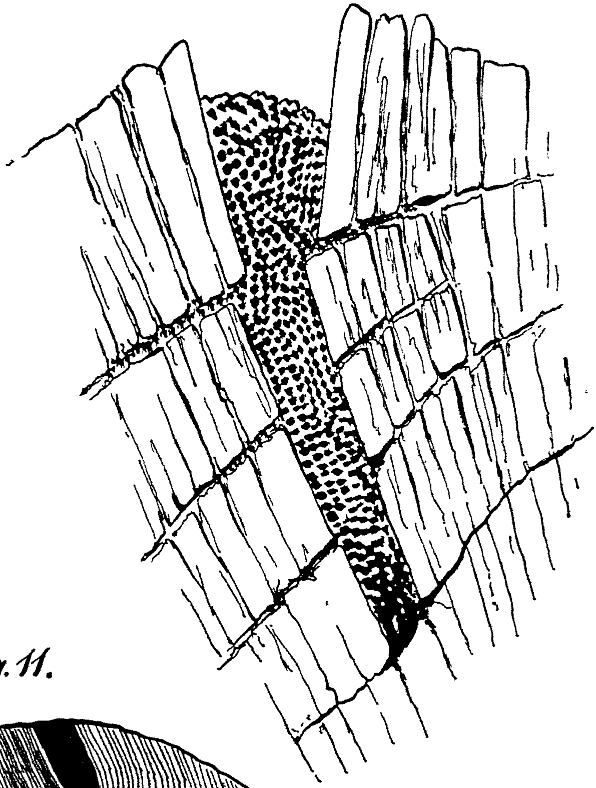
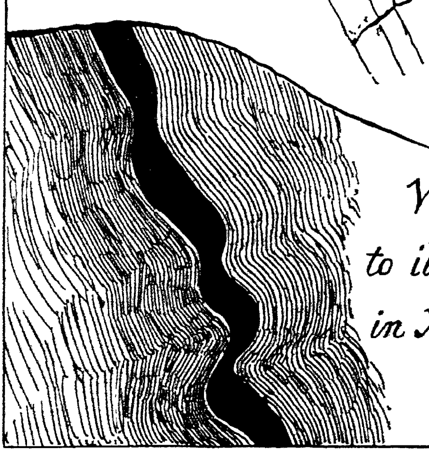


Fig. 11.



Vertical section, to illustrate Swellings in Magnetic ore beds.

I sandstone south-east of St Paul's church, dipping N. 60° E. 65°.

Again it has been opened on the south side of the Cotton road, ½ mile south-west of last locality, where it is so silicious and filled with chert and gravel as to render its recognition difficult. The dip is apparently overturned here S. 10–13° E. 63°-80°.

The large gravel bank south-west from here, at bend of White House road, shows cherty limestone also, dipping S. 5° E. 85°, strongly marked with cleavage.

About 6 feet of good white and blue limestone is exposed at several places in railroad cut, north of the Reading Iron Works, dipping S. 39° E. 75°-80°, accompanied with fine gravel.

North of the church, and on north side of small stream running down through the city a good face of limestone from 30 to 40 feet thick is shown in *W. Long's quarry* dipping N. 10° E. 70°, but of poor quality.

In the north-east corner of the city, high up on hill, a small quarry shows No. II blue limestone, dipping away from Mt. Penn anticlinal, S. 50° W. 18°.

A couple of limestone dips are shown on map west of the P. & R. shops, and south of Cemetery hill, dipping S. 25° E. 30°-35°.

North of Bushong's old hematite mine, which is abandoned, and shows nothing but drift and a little limestone in bottom, a series of fine exposures occur along the east bank of the Schuylkill as far north as the creek heading up to Barnhart's dam. The first exposure above the bridge is about 20 feet of thickly bedded magnesian limestone, with dips of S. 5° W. 33°, and S. 26° E. 38°, succeeded in 600 feet by a bluff with dips of S. 20°-23° E. 20°, 26°, 36°. Massive thick bedded limestone outcrops 500 feet north from here, dipping about due south 34°, succeeded in 200 yards by dips of S. 15° E. 41°, and S. 39° E. 19°, creating a 20 foot bluff here.

Four hundred yards north, there is a fine exposure of massive blue and white stone, apparently showing cleavage

of N. 32° W. 58°-60°, and dipping S. 20°-23° E. 42°, though possibly the first may be dips and the latter cleavage.

Just below dam at canal lock, 400 feet, limestone is seen, dipping S. 3° W. 45°.

Half mile east from here on Reading-Tuckerton road the limestone outcrops, dip about S. 30° E. 24°

South from here 800 yards, and just below the Riverside hotel, the road rises up Cemetery hill and passes over the north margin of the Hudson River, No. III slates here exposed in road, dipping S. 20° E. 37°.

At north nose of hill another exposure of slate is seen close to railroad, dipping S. 25° E. 38°.

On west bank of river the limestone widens considerably, and the following notes on such portions of Cumru and Spring as are shown on the Index map are compiled from surveys of Mr. R. H. Sanders and some hurried observations of my own.

The south limit of the limestones is marked by the Angelica creek from the Schuylkill as far west as S. Shepp's place near the Centre hotel, where the limestone turns nearly due west just north of the Shillington road and thence north of Potsdam sandstone hills and up creek in a narrow belt nearly to the Five Mile house.

Potsdam (No. 1) slates lie to the north of it here, around which the main body of the limestones swings into Spring township and continues its way west through the Lebanon Valley north of the limits of the map.

South of the Lebanon Valley R. R. bridge several good exposures are shown in the abandoned cuttings of the South Mountain R. R.

The first dip south of the bridge is about S. 15° E. 52°, massive blue and white limestone, soon followed in about 400 feet by a dip of N. 12° W. 35°.

The roll is but a local one, the limestones soon dipping to the south-east, as seen in the dip of 50° just north of ravine, which exposes a rather slaty variety of blue stone quarried further west in ravine.

Just west of the Harrisburg bridge a fine exposure of

nearly 100 feet of variegated limestones is shown in the S. M. R. R. cut and quarry of G. Frill, where I measured the following section, beginning at north end of exposure :

White banded limestone,	4′
White limestone, massive,	4′
Blue, cherty, and quartzose limestone,	3′
White and dove-colored compact limestone,	5′
Slate band, fissile and broken,	2′
White thick bedded limestone divided by cherty layers 6″-10″ thick,	6′
Massive dove-colored limestone,	4′
Slaty limestone, dove and blue color,	3′
Massive thick bedded blue quartzose limestone,	12′
Pink and dove color, banded limestone,	2
Blue and white banded limestone, with some chert and quartz grains,	12′
Good blue massive limestone,	6′
Slate band,	1′
Blue and white mixed, 2′ blue, 2′ white, 2′ blue,	6′
Slate,	2′
Blue partly massive and partly slaty,	3′
White quartzose and crystalline,	2′
Dove-colored limestone streaked with blue,	3′
Grey-blue massive limestone,	4′
Pink and dove color limestone,	4′
Slaty and slaty limestone, south face,	10′
Total,	98′

The limestone here is comparatively free from cleavage, some little with N. W. dipping planes showing at north end of section. The dip is S. 25° E. 40°-50°, the difference in angle being due to small rolls in the whole mass of the exposure.

Continuing down river, limestone again outcrops on road about 500′ north of Lancaster bridge, white and crystalline, and dipping N. 65° W. 44°. On public road leading out from Lancaster bridge, and about 200 feet from west entrance, limestone dips S. 50° E. 42°.

About 500 yards S. E. along road limestone again shows in a small outcrop, dip S. 68° E. 30°, with north dipping cleavage.

About 200′ north of Angelica creek, crossing on road, grayish white limestone outcrops, dip obscure but probably N. 30° W. 80°. This is close to the junction of No. 1,

which spreads over two small hills on either side of Angelica creek, and extends north along W. & N. R. R. to within 800 feet of first bridge.

The first dip in limestone north of Potsdam boundary is about S. 30° E. 80°, which, however, may be cleavage, followed in about 200 feet north by a dip of N. 40° W. 42°-70°. North-west of, and just above W. & N. bridge, *Geo. Long* has opened two quarries in gray massive limestone, used by the Monocacy Iron Company, who furnish the following analyses:

No. 1, Blue Stone. Booth, Garrett & Blair, May 29, '80.
No. 2, Limestone. Booth, Garrett & Blair, July 26, '81.

	(1)	(2)
Carbonate of Lime,	52.67	47.316
Carbonate of Magnesia,	44.64	40.509
Oxide of Iron and Alumnia,	1.27	2.275
Silica,	1.42	9.900

The first one, and larger of the two, is about 100 yards north of bridge, and shows about 30 feet of limestone with 10 feet of dirt covering. Dip here about S. 40° E. 50°, limestone considerably altered and broken up, with irregular cleavage.

The second quarry, further north, shows dips of massive limestone, S. 40° E. 40°-84°. Both show an excellent quality of soft dolomite.

Along road from Lancaster bridge, and about 800 yards S. E. of One Mile house, there is a small quarry in No. II, showing blue massive limestone, dip S. 60° E. 65°; and going up hill to the east, good blue limestone shows with a dip of S. 40° E. 10°. On top of hill, about the 320′ contour, limestone dips S. 10° W. 25° ?

South of W. High's place, 800 feet on same road, there is another opening in blue limestone, showing a dip of S. 20° E. 40°, succeeded by a small bunch of gray slate just where road crosses over nose of small hill.

Slate shows again at small creek-crossing at Shepp's mill, followed 600 feet south, near junction of crossroads, by limestone, no dip.

A brown slate, probably No. I, shows just at junction of cross roads, close to Potsdam sandstone.

Nearly a mile N. E. of Shepp's mill, down Angelica creek, limestone shows in a small quarry, north side of creek, and east of J. Bretting's house.

On road leading up the valley of the Wyamissing, an outcrop of blue limestone shows at junction of first road to right, dipping S. 10° E. 20°; also a dip of S. 30° E. 15° of same limestone 600 feet west on small road.

Just beyond cove on main road, 500 yards from intersection, blue limestone shows, dipping about south 15°. On north side of creek, in hill side, just opposite last locality, blue limestone shows, dipping S. 30° E. 15°.

Fifty feet (50') below this is a greyish-white altered limestone, under which blue limestone again occurs.

On road at J. Ruth's grist mill, blue limestone dips east 10°, though 200 yards down creek the dip is S. 20° E. 54°.

On top of hill summit 500′, south of road, a small patch of No. III slate occurs, massive and highly altered.

South-west along road from Ruth's mill, limestone first shows at old lime kiln, with some slight rolls, but no good dips. Further along road 400 feet, blue limestone shows, dipping S. 10° W. 20°, and south of J. Hill's house in hill-side, blue limestone dips N. 70° E. 10°.

Close to junction of road at Sol. Gaul's house, a quarry has been opened in good blue limestone, probably 30 feet thick, dipping S. 70° E. 10°, but generally flat, succeeded on road to N. W. by a dip at lime kiln of east 15°.

Further along this road, and on north slope of hill, blue limestone outcrops dipping S. 50° E. 30°.

On hill to left of this road the dip is to the south 45°, and on ridge between two roads, S. 10° E. 40°.

Taking road from Sol. Gaul's to Mt. Pleasant hotel, two dips of limestone show just before coming to bend of road, the first, blue limestone S. 30° E. 20°; the second slaty and massive blue limestone, S. 30° E. 30°.

Dips in the same direction are seen just beyond turn of road 40° and 30°, the limestone narrowing here and dipping at end of creek close to slates due east 30°, light grey in color and slightly altered.

These slates Mr. Sanders considers equivalent to No. 1 (Primal) series.

They occupy a considerable area at the eastern extremity of Potsdam sandstone hill; they are much broken, though occasionally showing massive beds, and are of a brown to grey color.

Their junction line is arbitrarily drawn in as they seem to grade imperceptibly into the limestones, which latter show a dip to the south 50°, intercalated with these slates, on south side of hill near the creek.

Chapter VI.

The Mesozoic formation east of the Schuylkill.
(*"Trias;" "New Red;" "Norristown Sandstone," &c.*)

A general description of this great formation is reserved for the report (C^7) on Bucks and Montgomery counties. In this chapter will be noted all the facts observed along the northern edge of the Mesozoic area inside the limits of Berks county, between the county line and the foot of the mountains.

These facts are chiefly of five kinds, relating: 1, to the unaltered *red sandstone* and shale beds; 2, to the *trap dykes* and altered beds; 3, to the *conglomerate* beds; 4, to the partly concealed and partly exhibited contact of the red rocks with the No. II limestone; 5, to the steep abnormal south and south-west dips, &c.

The term *Mesozoic* (Middle Age) is applied to this formation, because it was deposited after all the *Palæozoic* (Old Age) formations had been completed, and lifted out of the ocean, at the close of the uppermost coal measure (Permian) era,—at which time middle, northern and western Pennsylvania became dry land, leaving a belt of eastern Pennsylvania still under water.

In England, rocks of this age were called *New Red* to

distinguish them from the older *Old Red Sandstones* of Scotland, made famous by the researches of Hugh Miller. Everywhere else in Europe they received the name *Trias*, (Threefold) because the formation was generally divisible into three distinct members; an upper *Keuper* red shale; a middle *Muschel Kalk* limestone; and a lower *Bunter* (variegated) sandstone. But a fourth or uppermost *Rhætic* division was subsequently added.

It is not certain that the change from sea to land took place at the end of the Permian age. Therefore, it is possible that the bottom beds of the Mesozoic region in Pennsylvania and New Jersey should be called Permian; but that discussion does not belong in this report.

The north edge of the Mesozoic is seen, on the colored *Index Map* in the Atlas, entering Berks, from Lehigh, just south of Corning station (Perkiomen R. R.), and ranging through Hereford, Washington, Colebrookdale and Douglass townshhips, about S. 40° W., parallel to the Montgomery county line. About 1 mile S. W. of Greshville it bends to the W. N. W., and runs through north Amity and Exeter to the Schuylkill, north of the Big dam 3½ miles S. E. of Reading; and so on west into Lancaster county.

This north border line of the Mesozoic in Berks county is about 25 miles long.

The contact of the Mesozoic with limestone No. II is almost everywhere expressed by this line. In other words, the red rocks are seen close to or lying on the limestones,—except at a place between Clayton and Barto (Washington township) where they overlap the Potsdam sandstone No. I, and also the South Mountain gneiss,—and at Boyertown (Colebrookdale township), where they are seen (on Philadelphia avenue) abutting against Potsdam.*

The decided *red color* of all the Mesozoic rocks in Berks

[* These are important facts. They show that there was deep erosion of the limestone country south of the mountains previous to the deposit of these red rocks; at the same time the north dip of the red rocks in the hills of Dauphin county, overlooking the limestone valley at Hummelstown, shows that the limestone valley had *not* been eroded below a plane at least 500′ above the present surface, when *those* red rocks were deposited. This is the true explanation of the entire absence of Mesozoic red rocks in the Great Valley. J. P. L.]

county strikes the observer. The topography is undulating; the hills are furrowed; the soil is red; the rocks are beautifully stratified; fine-grained, compact, hard clay *sandstones*, alternating with beds of soft *shale*, and cut and parted by beds of *trap* almost as plainly stratified as the red rocks themselves.

These alternations of sandstone and shale are especially well seen near Ironstone station; at Neiman's mill; and along the Colebrookdale RR. to Manatawny station.

Other good alternations of massive sandstones and shales appear along the Reading RR. north of Exeter station; and also at various places west of the Schuylkill.

These *Mesozoic sandstones* are seldom valuable for building stone. They rarely deserve the market names *freestone* and *brownstone*; and although a few layers have been utilized, quarrymen must go further down the Schuylkill to open satisfactory quarries.

The *Conglomerate beds* (described below) make picturesque rounded hills somewhat higher than the general red country.

The shales weather to a sticky, wet clay soil. The sandstones make a porous drier soil; the whole surface is easily tilled, and mostly under cultivation, the sandstones being of shaley constitution, although massive, and the shales being so soft that the ploughshare can cut into the solid mass underlying the soil.

Where trap dykes have baked the Mesozoic strata, they seem to have affected the shale beds much more than the sandstones. Near Boyertown all the rocks have been metamorphosed into very hard slate. In the hill east of Little Oley the shale, baked by the Gabel Hill trap, has lost its red color, and is excessively compact and hard, breaking with a clean smooth fracture, and ringing when struck. The sharp, rough fragments covering the east flank of Gabel Hill show how little this metamorphic shale is affected by exposure.

On the other hand the sandrocks south of Jacksonwald have scarcely been changed by the two trap dykes there.

Trap dykes cut the South Mountain gneiss and the val-

ley limestone ; but they appear on their largest scale in the Mesozoic district. The most prominent are:

1. East of Bechtelsville in Washington township.

2. *Gabel Hill* at Boyertown.

3. Two V-shaped concentric hills S. E. of Jacksonwald in Exeter township.

4. The long dyke west of the Schuylkill from Birdsboro, through *Flying hill*, to the second W. & N. RR. bridge above the Little dam ; then turning at a right angle west through Cumru and Spring into Lancaster county.

5. *Monocacy and Rattlesnake hills*, two isolated knobs in the red shale plain in south Amity.

Small *trap dykes* traverse the gneiss at Babb's tavern ; and the limestone at Oley line.

All these trap dykes appear on the Index map, and their descriptions will be found further on in this chapter. The apparent disturbance of the Mesozoic strata by these traps is usually slight. It seems to be of little value as a factor in the discussion of the general north dip.

The *dip of the Mesozoic* formation as a whole is certainly northward, towards the South Mountains ; and the whole formation as exhibited for 30 miles along the Delaware river, seems to be 30,000 feet thick. But in Berks county a very different story is told which casts a doubt over the apparently simple calculation. Numerous steep south and southwest dips will be found recorded on the sheets in the Atlas accompanying this report (D[3], Vol. 2.) But another argument is obtained from the north dips in Berks county, thus :—

From the Montgomery county line, at A. Schultz's house in Washington county, to the north border of the Mesozoic on Perkiomen creek east of Barto station, is a distance of 6400 feet. The average dip, 30°. Calculated thickness of Mesozoic at Schultz's, 3000′. Nevertheless Mr. Schultz's water well struck the limestone floor beneath the Mesozoic at less than 200′.

The commonness of northerly dips is remarkable ; the *direction* varying between N. 15° E. and N. 15° W. and the *steepness* varying between 5° and 30°. This is charac-

teristic of the belt of Mesozoic in Berks county lying between the edge of the formation and a well-marked *anticlinal axis* south of Ironstone station on the Colebrookdale railroad.

This *Ironstone anticlinal* runs through Amity township, and throws off S. 20° W. dips (usually) varying from 10° to 80° in steepness: all the rocks, conglomerate included, being thus slanted south south-west.

These *south-westward dips* extend far enough to include the trap country of Exeter township south of Jacksonwald. The disturbance here ends, and the normal *north-west* dips prevail to and across the Schuylkill, averaging 20° in strength.

The Mesozoic sandstones and shales cannot be grouped into sub-formations, for they are not alike. When traced by outcrops the shales graduate into sandstone and the sandstones into shales. The whole mass seems to be destitute of fossils.*

The *conglomerate beds*, however, are quite separate, being confined to the border of the formation in Berks county.

They should, therefore, form the uppermost sub-division of the whole formation. But such a sub-division cannot be established even in the limited Mesozoic district of Berks county, because the beds are not continuous, but appear in irregular patches at intervals along the Mesozoic border, heterogeneous in character and broken in outcrop. It will also be shown directly that they may lie at the bottom instead of at the top of the formation.

The Mesozoic conglomerate in general is a breccia or mass of fragments, apparently swept pell-mell into the water and afterwards cemented together. Most of the fragments have come from the No. 1 sandstone and No. II limestone rocks. A small proportion of quartzite fragments are intermixed. The cement is a brownish-red clay.

Towards Lehigh county the conglomerate is a hard, compact, firm, gritty rock. Going west it assumes a more cal-

*At least no fossils have been seen by me or reported to me in Berks county.

careous type. In Amity township its limestone fragments become more abundant. West of Poplar Neck, in the cut of W. & N. R. R. (E. High's), it is so calcareous a breccia as to be burnt for lime, and many of the farmers prefer it to the limestone of the mother quarries in the No. II limestone itself, although it does not yield as much quick-lime to the ton. Still further west, at the Island mine and Raudenbusch's mine, it is very calcareous. At the Wheatfield mine it is so fine grained as to be easily mistaken for a stratum in the limestone formation No. II of the Great Valley.

Much of this conglomerate takes a high polish and makes a good building stone. It is variously known as "Potomac Marble" and "pudding stone." Its favorite title among the farmers is "all sorts."

It plays a prominent rôle in the geology of the magnetic ore district of Berks county, being found in close proximity to the largest mines. The broken range of its exposures is shown by a special color on the Index Map.

The easternmost exposure in Berks county is just opposite Clayton (Washington township), in a small knoll at the edge of the limestone.

Loose chunks lie on the hill opposite Bechtelsville.

At Boyertown it makes the "200 foot thick" *top-rock* in the Warwick and Gabel mines. Some diamond-drill cores of it from the Warwick shaft are in the museum of the Survey.

Its strong *south-west dips* in Amity and Douglass townships *would seem to place it at the bottom of the Mesozoic formation* , instead of at the top.

At March's mill-dam, it occupies the bed of the Manatawny in Amity township; is distinctly stratified in beds; dips 22° to 33° towards the *south-west*; and is cut by a small trap dyke, as seen on the public road.

The width of the conglomerate belt here is scarcely 200 feet.

Further west the belt swells rapidly so as to occupy all the northern half of Amity township, to the Exeter township line, and along the Oley-Exeter line to the west branch of Limekiln creek.

On the Reading road, 1 mile west of Stonersville, (Exeter township,) a small patch lies close to the north flank of the trap dyke. Hence westward, and nothing is seen of it until—

South of the *Kinzi Mount dyke* it occupies a considerable belt or tract, extending from Hertzog's (once Bishop's) mill westward to the Schuylkill river at Big dam.

This belt is 2,000 feet wide; prevailing N. W. dips varying from 12° at the mill, to 60° at the dam.

At the Schuylkill it overspreads all Poplar Neck south to the Flying Hill trap; then contracts to 500 yards between the trap (at the point of High's woods at the Little dam) and the W. & N. R. R. second bridge.

Underlying the northern part of Fritz's island (in the river) it is pierced by the two Island mine shafts.

West of the Schuylkill it is repeatedly seen; but is largely exhibited only at the Wheatfield Ore Banks, where it looks like limestone, and is cut by trap dykes, developing ore horizons.

The trap appears frequently to be as distinctly bedded as the sandstones and shales. Much of it may be merely these shales changed into trap. The trap rock proper has come up through the deep underground floor, and then lifting the Mesozoic strata, has flowed out sidewise between them.*

The whole country has been eroded; the general surface has been lowered; the outflow of trap over the original surface has been carried away; and the hard edge of the dyke now forms a bold ridge. But in some cases the trap never reached the original surface, and was closed in on top by the Mesozoic beds. A proof of this is found in the fact that the Mesozoic rocks still lie upon the very top of the trap hills at Boyertown and Jacksonwald.†

The plate-like character of the trap seems well established at Flying hill; for it is frequently interstratified with con-

*This theory has been proved in Massachusetts by a bore hole 2000′ deep, which did not strike the trap, although it was bored only about 1000′ from the place where the slanting trap sinks beneath the surface. Had the trap continued down the dip the bore hole would have struck it at about 500′.

†See illustrations of this in the New Jersey Geological Report of 1882. Martin's Dock.

formable bands of shale and sandstone. The crystallized basaltic trap, a variety supposed to have been comparatively free from pressure in its formation, has only been noted in two places so far; in Kaufman's quarry south of Oley Line Hotel and on the Tulpehocken creek in a limestone quarry about 1½ miles above its confluence with the Schuylkill at Reading, which is no doubt a portion of that eruptive dyke strongly marked in the Potsdam sandstone on the east flank of Milbaugh hill (and shown on the index map), and again exposed on the Reading-Tuckerton turnpike, in No. II limestone about half mile north of Tuckerton near Geo. Moser's house, as a 6-foot fine-grained trap bed.

The Little Dam trap along both sides of the Schuylkill south of Reading is largely composed of basic feldspar (plagioclase) and hornblende with some epidote and chlorite.

It is a diorite, of greenish gray and black color and coarsely crystalline texture, whilst that south of Jacksonwald in Exeter is a diabase containing augite (pyroxene) and feldspar, and is a hard compact close-grained black trap with a vitreous lustre.

The Boyertown trap is a hard greenish black variety impregnated with chlorite, feldspar, and grains of olivine and also carries in it a considerable percentage of magnetic iron ore.

It decomposes to a dull earthy brown soil, well exposed in the cut immediately south of the Gabel mine, which decomposition is largely due to its feldspar, and everywhere here bears a strong resemblance to syenite. It is really a "Greenstone" or chloritic mixture of diorite and diabase, and plays an important role in the two largest magnetic mines of the district.

Detailed description of Mesozoic dips, &c.—Beginning on the east at the Lehigh county line, a flat plain of red shale occupies all the country as far west as the Perkiomen creek south of the narrow limestone valley into Montgomery county.

Just south of Wiegner's saw mill on the Perkiomen creek,

60 feet of red shale, broken and decomposed, is exposed on public road dipping N. 22° W. 9°.

A purplish red soil covers the hill to the south-west divided from the limestone soil on the north by the branch to the Perkiomen.

Red shale is again exposed in gutter on public road 500 yards south-east of Clayton, dipping N. 20° E. 30°. Just across cove 400 yards south of road, the small knoll summit 500′ contains the first patch of conglomerate met with in the county.

It occupies a limited area back of David Gerhart's dwelling, exposed for probably 50 feet, and of so calcareous a character as to have been opened for limestone in several small quarries.

The dip is about N. 25° E. 35° and exposure 25 feet thick. Near the base of the hill there is a six foot bed of calcareous breccia exposed where most of the quarrying has been done.

The rest of the outcrop is made up of small pieces of red shale and sandstone, angular quartzite and flint particles, cemented with a limestone clay.

The calcareous layer is of a bluish-white color, and closely resembles that quarried at the Big Dam on the Schuylkill south of Reading.

On the Montgomery-Berks county line road, due east from Churchville, there is exposed in small hill south of creek, a hard blue and white crystalline rock, which effervesces when touched with acids, and which is probably an outlying patch of No. II, here left bare by the denudation of the thin covering of red shale.

Half mile south-west of the conglomerate exposure, the Mesozoic sandstone, still limited on the *north* by the creek, laps completely over the limestone, and adjoins the Potsdam sandstone all the way to the west branch of the Perkiomen creek east of Barto station, crossing the Swamp road at the Lutheran church south of Churchville, and lapping in turn over the Potsdam and Laurentian gneiss as far as the head waters of Swamp creek near Eshbachville, where it again meets the limestone. One mile south-east of Churchville,

at bend of road at creek crossing, dipping N. 20° W. 12°–15° red shale and sandstone are exposed, showing in the hill south from here to Oberholtzer's store some slight alteration to a mud rock.

South-west from Oberholtzer's store just across Perkiomen creek, altered shale is exposed in road cut, dip S. 80° W. 30°.

The high land between this point and the road leading from W. Stauffer's saw-mill to the Montgomery county line, nearly parallel to the Washington-Colebrookdale line, is composed everywhere of indurated red and gray shales, metamorphosed by the bold trap dyke shown on the index map.

No well-defined line divides the trap from the red shale and sandstone, boulders of the former being spread profusely over the crest and flanks of the hill; but the Swamp road on the north and a small creek heading up to L. Bechtel's place on the south, approximately mark its extent.

The dyke is composed everywhere of a fine-grained black crystalline trap, a diabase containing small grains of magnetic iron ore and some little augite. Towards the south-west it forks into two branches, the north one ending in the sharp hill sloping down to Stauffer's mill, and the south branch extending in an equally prominent ridge to the county line. Between them a gently rising hill intervenes, composed of red shale mud rock though carrying many boulders of trap on its flanks.

Several shafts have been put down in this hill for iron ore and some very excellent material obtained from the Gilbert mine located here, though no regularity is reported in the deposit.

The dyke proper extends north-east as far as the road from S. Latshaw's house to the Swamp road, here greatly contracted and covering an area with its boulders about 500 yards wide;—but the whole hill to the north-east of this road has been more or less affected by this dyke, so that the rocks bear the appearance of having passed through a furnace, where all softer constituents have been burned out and left instead holes of all sizes.

A patch of conglomerate (loose) was found on the public

road near Latshaw's place, but no rock in place could be found.

West of the school-house on top of dyke, trap is exposed dipping S. 20° E. 61°; and again on road above M. Moser's house, in the north branch of the dyke, dipping S. 35° E. 80°.

On other flank of hill, 500 yards east from the latter exposure, the dip shows S. 40° E. 85°, and on public road south 600 yards a dip of S. 77° E. 75°.

The trap here is greatly decomposed, showing a greater quantity of hornblende and apparently some little cleavage.

In creek bed north of Benfield's place a 2′ bed of trap is exposed, out from the boundary of the general dyke and in New Red shale, dip S. 55° E. 75°.

The southern branch of this dyke has made itself felt some distance south along the county line, metamorphosing the shales into grey slates and totally changing the usual direction of dip to successively S. 60° W. 45°, S. 54° W. 70°, S. 57° W. 55°.

Another small patch of trap of similar character is shown on map in the small hill south of Johnson's mill, north-east of New Berlin, showing a dip at the mill of S. 88° E. 80°, and turning over the shale on road to New Berlin to S. 37° W. 87° in a 15 foot exposure.

From this dyke to Philadelphia avenue at Boyertown all is red shale interstratified with sandstone, showing in the railroad cut just above Boyertown, some little conglomerate in a 50 foot exposure, all dipping about N. 15° E. 15°.

On the county line north from Philadelphia avenue red shale is exposed at roadside, dipping N. 42° E. 10°-12°, and again at small creek N. 14° W. 15°.

At J. Bower's place 300 feet further on, at road to New Berlin, the dip seems to be N. 66° E. 35°, the formation here being greatly contorted, succeeded ½ mile along county line by dips in red and grey shale of N. 68° E. 15°-25°.

The first dip S. W. from Philadelphia avenue on road to Englesville is a red shale near small stream N. 45° E. 25°.

Further south-west ½ mile shale again outcrops on road near old brick yard, dipping N. 10° W. 12°.

In railroad cut 300 yards S. W. from Boyertown, and just beneath Englesville road bridge, red shale and a little conglomerate show in a 35 foot exposure, dipping N. 15° E. 12°, which is the last exposure north of the Gabel Hill dyke.

Continuing down railroad from road bridge a little limestone clay similar to that exposed at the brick works at New Berlin is seen, after which the railroad swings around north base of trap hill.

Just south of the Gabel mine there is an exposure of indurated New Red shale, metamorphosed here as elsewhere in the country back of the trap dyke into a mud rock, often entirely deprived of its characteristic red color, and appearing as a hard grey slate.

Just at north base of hill the brownish-red soil of decomposed trap is exposed in railroad cut, greatly weathered and showing a doubtful dip of N. 78° W. 73°.

The next exposure 60 feet further down track, shows the characteristic fresh trap of this dyke, essentially a greenstone, very hard and tough, and bearing many of the physical and lithological features of syenite.

Frequently bottle green crystals of chrysolite or olivine, epidote, pyroxene, stilbite and iron pyrites, are disseminated through the mass.

Augite and feldspar, and grains of titaniferous magnetic iron ore are likewise often present in this rock, which weathers to a dull brown earth filled with white feldspar grains.

It breaks when fresh with conchoidal fracture, into irregular angular blocks, with sharp faces and a smooth polished surface.

The next exposure is in long cut on railroad 25 to 30 feet deep, and nearly 200 feet long, just above public road crossing over hill from Morey's mill. It is composed almost entirely of greenstone trap, so cut up into curving plates standing on an edge, that a different dip might be obtained every few yards.

A general dip of S. 70° E. 70° into hill, may, however, be assigned to it.

This cut shows many smooth surfaces where drills for blasting have been put into the rock, which is uniformly of a dark black green color.

The trap is by no means solid along the line of its exposure, but is often broken up into small blocks similar in character to basalt though not so highly crystallized.

Just north of trestle bridge, over public road, at south end of cut the dip appears to be about S. 45° E. 85°.

The trestle bridge here over Ironstone creek, is about 130′ long, after which the railroad passes through a 20 foot cut of dark colored trap on north side, occupying rounded hill south of the Pottstown road and divided from the larger trap hill south of Gresh's quarry, by a narrow cove showing New Red indurated shale.

In middle of cut the dip is apparently S. 45° E. 70°–80° jointed and irregular, and becoming vertical in some places. At south end of cut the dip is S. 40° E. 80°, and on Pottstown road S. 46° E. 85°. The cut is about 80′ long. Four hundred feet south, just at red shale ravine, there is an exposure of trap dipping a few degrees west of south 88°, mixed here with red shale.

South again from this point 150 feet there is an exposure of hard compact gray slate dipping N. 35° W. 85°, outcropping in various places along railroad near here and finely exposed on road on *east* side Ironstone creek.

It is everywhere a dull bluish-white mud rock, an altered shale, so metamorphosed and baked by heat and pressure and thrown up on its edge as to be distinguished with difficulty from a true trap itself.

Four hundred feet south from last outcrop, the same slate is exposed on railroad opposite Colebrookdale Iron Works dipping N. 40° W. 60°.

The next exposure 600 feet south looks again like trap with a dip of S. 40° E. 60°, though but slightly exposed. Gray slate again appears just north of public road at Colebrookdale RR. station dipping N. 70° W. 50°.

Two more slate outcrops occur before reaching the Gresh-

ville road south of the station, the first a doubtful dip of S. 45° E. 50° and the second N. 30° W. 88°.

The decomposed rock in road cut immediately behind station house appears to be trap, showing a dull brown earth with feldspar crystals similar to that exposed in the south face to Gresh's quarry.

Meanwhile the Gabel hill dyke preserving a course nearly parallel to the Montgomery county line from the mines to the Douglas line, here turns suddenly to the E. S. E. passing over the Englesville-Little Oley road south of S. Pusher's house.

Though confined to the crest and west flanks of the hill, where its effect on the topography will be readily seen, it has nevertheless furnished a large quantity of boulders to the gently sloping east flank, strewing the country down to the Englesville road.

It has, moreover, completely metamorphosed this country rock, as before explained, into a grey and pink slate.

In the road below Major J. Wren's house on north flank of hill dips of S. 15° E. 70°-78° and S. 30° E. 80° are exposed.

The dyke apparently does not extend as far south as right angled bend of road south of S. Pusher's house, for in side-hill there are two exposures of altered New Red, varying from white to light blue, occasionally slaty, but generally hard and compact, and showing angular edges when broken.

The first exposure further east dips N. 30° W. 85°, the second N. 22° W. 78°.

South from Greshville road, and below small stream heading up through altered shale, there is another trap hill striking due north, but turning N. E. before reaching the Reading road to join the dyke south of the Greshville quarries.

The outcrops along railroad, however, all bear a closer resemblance to highly indurated shale than to trap, the latter being buried beneath surface and only manifested by its effects on the country rock.

At north end of cut on railroad a light grey rock is met

with, dipping N. 25° W. 55°, succeeded in 500 feet by a bluish compact rock, dipping N. 30° W. 60°, and freshly exposed several times in the next 200 feet, with a dip of N. 30° W. 62°, and finally N. 20° W. 30°.

This is the last exposure seemingly affected by the underlying trap dyke, as the railroad tangent beyond this point passes through a 20 feet cut of thickly-bedded red sandstone, dipping N. 6° E. 12°-20°, 200 feet east of road to Neiman's mill.

The hill on other side of railroad and south side of creek opposite that already described shows the same characteristics in its rocks and topography, and though also buried beneath the surface here to a probably greater depth, the trap no doubt exists as the tail end of the dyke just described, making it concentric to the Gabel Hill dyke, and producing a similar metamorphism in the Mesozoic red sandstone and shale strata.

The best exposures are seen along road north of Neiman's mill, where the first outcrop east of mill on road is a *red shale*, dipping N. 40° E. 40°, succeeded in 350 feet N. W. by broken red shale, dipping N. 60° E. 35°.

Close to mill in bank a similar dip in red rock (40°) was obtained, after which all the rocks to the north are metamorphosed.

Four hundred feet north from mill a fine face of indurated *grey* rock is exposed for 200 feet along road and cut down 30 feet in hillside.

It is very hard and emits a ringing sound when struck, and whilst having an average dip of N. 20° W. 30°, it is marked with distinct cleavage planes, dipping S. 40° W. 50°-70°.

The road from the Keely and Davidheiser quarries south of Greshville to Neiman's mill passes everywhere through red shale soil; but the metamorphic action of the trap dyke is well marked higher up the hill by the change in the topography about 200 feet east of the road, which, as shown in the boulders along the hillside, is really the limit of the grey and white slate.

On the railroad just below the road crossing, compact

massive red sandstone is exposed in a series of beds intercalated with red shale, dipping N. 10°-18° E. 30°, much of it "freestone" of excellent texture.

At bend of road to Neiman's mill after crossing railroad good "freestone" is exposed, dipping N. 38° E. 33°, outcropping continuously to bridge over creek, where it dips N. 52° E. 28°, in alternating bands of shale and sandstone.

East of Fritz's mill, to the south of Neiman's mill, a small shale outcrop appears in gutter on road, dip N. 48° E. 40°, better exposed in a large outcrop of sandstone and shale just behind mill, dipping N. 10° W. 20°.

Another excellent exposure is seen on road west of mill, dipping N. 10° W. 15°, the Mesozoic strata being a couple of hundred feet thick here.

Going up road to Ironstone Station these dips are duplicated, until on track 800 feet south-west of station a gentle but well-defined anticlinal arch in shale and sandstone is exposed throwing off dips to the N. 30° E. and S. 30° W. 0°-10°.

From this point west for over 4 miles, to and beyond the V-shaped trap dykes in Exeter township, south-west dips prevail and are indeed, almost universal, increasing in strength until the Limekiln creek is reached, and afterwards dipping more gently, but with always the same *south-west* direction.

Before reaching the Ironstone the dip varies from S. 30°-44° W. 30°, after which a variety of dips too numerous to mention can be obtained in any of the numerous hills and red shale valleys as far west as the Manatawny, varying from 15° to 45°, and generally about S. 40° W. These dips are all shown on Atlas Sheet XVIII.

The Manatawny creek, between the Pine Iron Works and High's mill south of Earlville, where it meets the limestone of No. II, shows a series of fine outcrops of shale, sandstone and conglomerate along its twisting and torturous course, and presents probably as good a place as any in the county, except along the Philadelphia & Reading R. R., to study the character of the several members of this formation.

At Pine Iron Works dam, shale outcrops in roadside dipping S. 60° W. 40°.

Three quarters mile north from dam on east bank of creek just at first bend to the west, shale and sandstone are exposed dipping S. 30° W. 30°.

Along south bank of creek and roadside for ½ mile N. W. of C. K. Mauger's place shaly sandstone is exposed, showing dips of 38°, 36°, 40°, and 35° to the south-west.

Going towards March's mill, red shale is seen south-west of mill dipping S. 60° W. 35°.

The creek bed and a narrow strip 200 feet wide on east side of Manatawny exposes coarse massive conglomerate pudding-stone, and here is the first outcrop of "Potomac Marble" met with west of Boyertown. The dip is S. 55°–60° W. 20°–25°, and it is prominently seen outcroping in many places in and along the stream.

About 200 feet east of mill, just beyond turn of road leading up small ravine to school-house—there is an 8 foot exposure of fine grained crystallized black trap dipping S. 80° E. 54°. It does not seem to have influenced either the character or dip of contiguous strata, for red shale 50 feet further on dips S. 36° W. 24°.

The hill to north of stream, with the exception of the conglomerate area already defined, is all red shale as far as the limestones south of the Reading road. The dips are about S. 24° W. 44°, and the measures show no signs of alteration whatever.

The creek above March's mill dam leaves the conglomerate to take a big bend into the less resisting red shale, which shows dips of S. 20°–45° W. 40°–50°. It soon turns north again and enters the conglomerate north of E. Rhoad's place, here about 400 yards wide.

On road and in hill south of Weidner's mill the conglomerate dips about S. 40° W. 30°, until at the next abrupt bend in the creek, north of Heist's mill, the conglomerate spreads out and occupies the whole country from the limestone on the north, south to the Weavertown road.

It is characterized here by beautifully-rounded hills,

bunched together with no regularity, but whose topography presents a particularly pleasing aspect to the eye.

The limit of the red shale and sandstone is marked by a small creek heading up from the Manatawny at the big bend below Heist's mill, crossing Amityville-Earlville road at J. Halloway's house, and extending up cove to a point on back road about 800 feet east of Weavertown.

Around Amityville all is red shale and sandstone interbedded, showing dips on road to E. Rhoads' place of S. 50° W. 42°, and closer to creek S. 54° W. 54°, here mixed with a little conglomerate in layers a few inches thick.

At Amityville school-house red shale outcrops in roadside, dipping S. 75° W. 43° and N. E. along Earlville road successive dips of S. 60° W. 55°, 53°, 56° are seen, the latter near creek slightly conglomeritic.

North-east from Halloway's house along same road several fine exposures of Potomac Marble occur, with dips of S. 60° W. 33°, S. 52° W. 45°, and finally just near mill S. 60° W. 50°.

These exposures vary from 10 to 25 feet thick, and consist of a coarse heterogenous conglomerate of limestone, sandstone, quartzite, and shale, with but little cementing material and capable of taking a fine polish. They resist the weather well and would make fine building material. These remarks are applicable to the whole conglomerate formation of Amity township, where it is finely developed and exposed frequently.

On the Manatawny south from Heists' mill, conglomerate outcrops twice in bank of creek, with dips of N. 88° W. 50° mixed with a little shale, and S. 50° W. 35°.

Conglomerate occupies the creek bed almost the entire distance between High's and March's mill, showing pit holes and cavities due to frequent abrasions from current boulders.

On the Douglassville pike between Amityville and Yellow House, there are some excellent exposures, where from the red shale border ½ mile N. W. of Amityville to the toll-gate, there are successive dips of S. 70° W. 50°, S. 60° W. 55°, S. 55° W. 38°, S. 60° W. 45°, S. 80° W. 55°–60°, and *at* the toll-gate S. 65° W. 54°.

On road south of High's mill, it is likewise exposed dipping first S. 60° W. 35° and further up hill S. 22° W. 40.

On small road from below Weavertown to Douglassville pike, conglomerate is exposed first at the school-house dipping S. 60° W. 60°, N. 70° W. 35°, and a splendid 20-foot exposure near pike of firm rock dipping S. 75° W. 75°–85°.

On small summit to west of this road dips of S. 80° W. 40° and S. 85° W. 55° were secured, the exposures sticking up out of the fields like so many little islands.

West from Weavertown along back road, the first exposure beyond school-house shows a dip of S. 45° W. 55°, succeeded beyond G. K. Lorah's house on road to Reading by dips of S. 70° W. 48°, S. 72° W. 50°, and S. 75° W. 50.

On summit 400′ to east of road, at junction of road to south, the dip is N. 85° W. 40°; and finally a single northeast dip of 34°, at the edge of the limestone east of L. J. Bertolet's place.

Returning to the back road at G. K. Lorah's place, further dips going west were obtained, two in the conglomerate of S. 65° W. 50° and S. 50° W. 60°—the latter just east of Sassaman's house and partially mixed with shale.

Mesozoic Red Shale appears again at A. Sassaman's place, skirting the conglomerate hills to the north and swinging up small creek as far as the 290′ contour and up the Limekiln and branches nearly to the Reading road. A small cove to the south of that road, admits of a narrow zone of conglomerate along the Exeter-Oley line as far west as the west branch of the Limekiln creek, showing dips at A. Gross' house on township line road of S. 10° E. 30°–50° and apparently *nonconformable* in its bedding here to the red shale on small road 200 yards to the south which dips S. 45° W. 46°–50°.

Though the conglomerate has narrowed down considerably along the Oley line, it is very prominent in the hill sides. Immense boulders weighing many tons have been detached and piled upon one another in irregular masses along roadside.

Two more patches of conglomerate occur before reaching the trap dykes of Exeter township, one on the Monocacy

at J. Smith's house at the junction of the limestones, showing thin beds made up of rather fine material and dipping S. 50° W. 40°–42°.

The second is on the Reading road one mile west of Stonersville, occupying a narrow zone from F. Ritter's to the smith shop and extending into the small rounded outlying hill west of Spring creek.

It is here very prominent and coarse in texture, throwing off many boulders through which the Reading road has been cut.

At Ritter's the rock is partially mixed with shale, and shows a general dip of almost due west 30°. West of creek the dip swings to the south and varies between S. 30°–45° W. 30°–40°.

All the country to east of the trap dykes, bordering Spring creek, the Monocacy and the Lime Kiln branches, is New Red shale with some little sandstone partings.

A series of excellent exposures may be obtained south of the *Friend's Meeting House*, beginning at E. Philip's house with a dip of S. 70° W. 68°, and almost continuously along same road west of smith shop in an exposure several hundred feet thick, mostly shales and shaly sandstone, with dips of S. 60°–70° W. 70°, 64°, 70°, 68°, 65°, and 50° close to creek with a dip of S. 75° W. 58° on top of hill near cemetery.

On road north from Meeting House, similar outcrops occur with dips about S. 60° W. 66°, 65°, and 55°, the latter close to the conglomerate ridge south of L. J. Bertolet's.

The *west branch Limekiln creek* shows dips along its banks of S. 50° W. 40° in shale and sandstone at H. Wentzel's house, due west 45° at Boone's saw-mill, and S. 60° W. 38°–40° at Bechtel's mill further north.

The road on top of hill west of this mill shows a considerable number of fine-grained trap boulders and soil derived from its decomposition, but none in place.

The Reading road west from Boone's saw-mill, shows outcrops of banded shale and sandstone, with dips of S. 50° W. 36° and 50° just west of wagon shop; S. 10° W 30° at

Monocacy creek; and S. 45° W. 22° one half mile west of Stonersville hotel.

West of the Monocacy and E. Kline's place at south border of map, red shale shows again with dips to south-west of 20° and 35°, and at Spring creek one half mile south-west of Stonersville dips of S. 80° W 30° and S. 60 W. 35° close to trap.

The two concentric trap dykes here met with in Exeter township form a prominent landmark in the topography of the country, rising from the west where their summits are about 400 feet above ocean level to the east, where they reach above 500′.

The level of the red shale country surrounding them and contained between their walls is about 300′, which unlike the Boyertown deposit, has not been changed in the least either in the position or character of its beds from the usual succession of shale and sandstone so familiar in the general formation.

This statement is capable of one restriction, however, namely, the *direction* of dip, which in the valleys between the trap dykes and all the country west to the Schuylkill has again changed to the north-west.

The position of these two dykes is shown on the Index map, and their limits are as sharply defined on the ground by the sudden change of topography, arresting the eye of the observer as readily as the change in the character of the rock does

The first and smaller one may be traced from the edge of the limestone ½ mile south-east of Brumbach's wool factory, E. S. E. to H. Bear's house, where it turns abruptly back on itself N. W. to a point on the Reading road 3,000 feet east of Jacksonwald.

The Antietam creek runs along its north base to a point 3,000 feet due south of Jacksonwald, where it cuts through its walls in a red shale strip of country 600 feet wide.

The south and larger dyke takes its rise under similar circumstances, about 500 yards south of its companion, pursuing the same general course E. S. E. to the Antietam

creek, which cuts through it similarly about 600 yards north of Hartzog's mill.

Appearing again on the east side of the creek, where it is known as the Kinsey Mount, it widens considerably while trending due east to within 800 feet of Spring creek.

Here it likewise turns back on itself to the N. W. widening for a time and again contracting near the Reading road east of W. Yeich's house, where it is lost beneath the red shale and limestone. Two sections across these dykes are shown in Figs. 9 and 10, page 219.

Section No. 1 is from a point in the No. II limestone on Spring creek to Stonetown.

Section No. 2 commences also in the limestone north of W. Yeich's place, to Philadelphia pike west of Hartzog's mill. The red shale valley included between dykes is from 200 to 800 feet wide, and shows everywhere north dips. The sections are about 4,000 feet apart, and are drawn parallel across dykes.

On road leading south from Jacksonwald, and just below Dietrich's, sandstone dips N. 43° E. 30°, followed at bend of road by a dark, fine-grained trap, containing a good deal of augite, and dipping S. 30° E. 52° and south 43°.

The north limit of dyke is marked by a small stream flowing into Althouse's mill dam. It extends along road for 400′ and is probably half that thick, succeeded by red shale along road for half a mile, when the north flank of the Kinsey Mount dyke is met with, the first dip being S. 65° E. 75°.

The trap here is lighter in color, and very much broken rendering dips doubtful; but it shows a general steep inclination to the south-east. Trap extends about 400 yards along road, slightly quarried at south end where the dip is S. 25° E. 60°. A variegated red shale and sandstone occurs here with it, dipping N. 65° E. 52°, apparently but little disturbed by the trap. Further south on road red shale dips N. 56° E. 25°, though the road is strewn with trap boulders as far as Hertzog's mill. On the extension of the Kinsey Mount dyke west, south of Althouse's Forge, a shaft 50 feet deep is located, close to road, known as Bishop's mine.

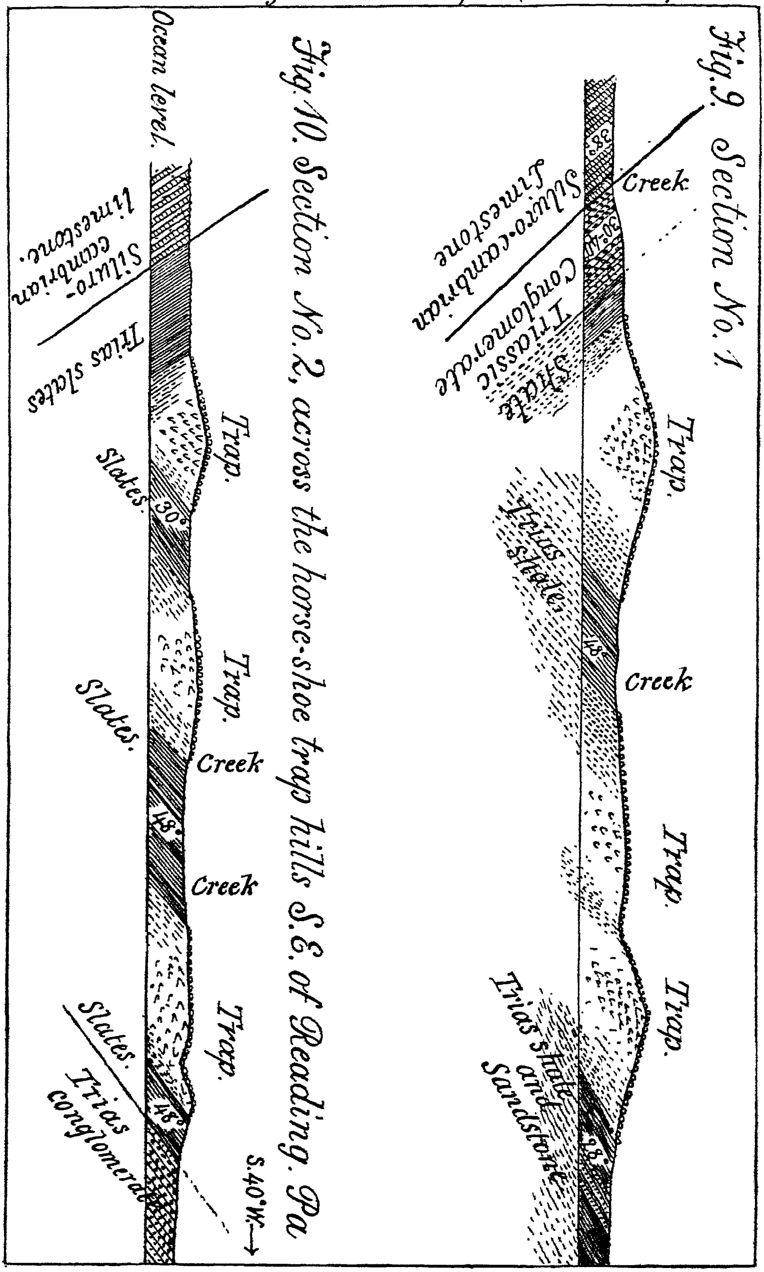


Fig. 9. Section No. 1

Fig. 10. Section No. 2, across the horse-shoe trap hills S.E. of Reading. Pa

It has been abandoned for some time, but is said to have yielded about 1,000 tons of ore.

North of W. Esterly's house to the south of mine, shale outcrops, dipping N. 10° E. 48°, succeeded by conglomerate dipping N. 20° E. 40°.

A narrow strip of red shade borders the south flank of the southern dyke, being divided from the succeeding conglomerate by a gentle cove running along east of and parallel to the Perkiomen pike.

No conglomerate is found *east* of Antietam creek, the country south of Kinsey Mount and through Stonetown being everywhere red shale and sandstone, though covered with many trap boulders along the Stonetown road.

Dips in shale east of Antietam creek are N. 56° E. 25°, N. 30° E. 26°, and N. 35° E. 40°, the latter west of J. Gilbert's house.

West from Antietam creek a belt of conglomerate extends to the Schuylkill, from 500 to 800 yards wide, and becoming more and more calcareous as it proceeds westward.

Its north limit is the trap with a little red shale and limestone already mentioned, while it is succeeded on the south by interbedded red shales and sandstone of the usual character, occupying all the country as far as the limits of the map.

Going along Perkiomen pike from Hertzog's mill towards Black Bear Inn several good exposures of Potomac Marble occur, especially in low ridge north of pike, where boulders of this rock are profusely spread over surface.

North-west of mill 800 feet, in pike on west bank of Antietam creek, the dip is N. 15° E. 12°, succeeded on road to Exeter Station by dips of N. 12° E. 22° and N. 33° E. 30°, the latter mixed with red shale.

South of this latter outcrop 400 feet a small trap dyke crosses the road, and may be traced by its boulders west along summit of hill north of J. Bechtel's house, though almost everywhere overlaid by red shale.

Six hundred feet north-west from intersection of this road with pike there is a large outcrop of conglomerate in

field north of pike, dipping N. 12° E 22°, filled with limestone and of a dull white color.

Further along north-west where pike crosses summit, and just west of the 4-mile post to Reading, conglomerate dips N. 38° E. 16°.

The hills to the west mark the presence of conglomerate by their rounded and bold topography, as well as by carrying on their summits large and small boulders of this rock; but no reliable dips were obtained until the Schuylkill was reached.

Along the east bank of this river, especially at the Big dam and in the Philadelphia & Reading railroad cuts, magnificent exposures of this rock may be seen, here very coarse and calcareous, and presenting solid walls with but little apparent bedding. The dip, however, wherever obtained, seemed to be a few degrees west of north, and from 20° to 60° in strength.

The red shale margin is readily noticed by the distinct change of rock and topography, and occurs about 1000 feet N. W. of Neversink Station, midway between the railroad and T. B. DeTurk's.

At Neversink Station the red shale outcrops in railroad cut, dipping about N. 10° E. 20°, succeeded going S. E. along track by dips of N. 45° W. 32°, N. 20° W. 20°, and N. 15° W. 55°.

South-east of private road crossing track below this point red shale again outcrops, dipping N. 55° W. 30°, while *south* of L. Reinhart's house on track and in public road the dips are N. 30° E. and N. 10. E. 30°.

An equal distance *north* of Reinhart's place the dip is about N. 10° E. 28°, whilst the dip on railroad S. E. at the limit of the map is N. 12° E. 15°.

On Poplar Neck, between the two sides of the great bend of the Schuylkill, the conglomerate has widened considerably, spreading south beyond the Wilmington and Northern railroad to the base of the Flying hill trap dyke, and occupying territory nearly a mile wide. A small patch of No. II limestone occurs at the northern extremity of the peninsula, dipping under the conglomerate 50°, the latter

lying *unconformably* on it and showing a dip at toll-gate of N. 15° W. 50°.

Both sides of river are covered with many boulders of river drift, partially hiding the red shale, which is the real country rock.

The Schuylkill river, after sweeping past the rugged Neversink hills, takes a big bend south of the Little dam before swinging around the equally prominent Poplar Neck.

This strip of land is about 3000 feet wide just south of the P. & R. cut, tapering slightly to the south, but the river makes a detour of over 2¼ miles around it, cutting through the Flying hill trap dyke, part of which is left on the southern point of the neck, as shown on the Index map.

North of the trap there is a strip of very calcareous Potomac Marble or Mesozoic breccia tapering from 3,500 feet wide on the east to half that width on the west, and a direct continuation of the Exeter township deposit.

North of the conglomerate occurs the limestone of II and No. I Potsdam quartzite of Neversink hill already mentioned in former chapters.

The Wilmington and Northern railroad passes into this Mesozoic breccia south of the second bridge, and remains in it through the long cut to the third bridge.

At north-west end of cut the dip is N. 10° W. 60°, in coarse conglomerate filled with sandstone and limestone chunks of considerable size. About the centre of the cut the dip is S. 65° E. 50°, and in a thickness of probably 40 feet of calcareous breccia, there are several bands of red shale 6″ thick.

At south end of cut, which is all through Potomac Marble, the dip is S. 60° E. 46°, showing here also an occasional layer of red shale, and some slight indications of trap, though this latter probably does not extend north of E. High's house.

The marble is composed almost entirely of limestone boulders from 1 foot down to a couple of inches in diameter, some few of them angular, but mostly rounded.

Some of them are quite decomposed, making a heteroge-

nous mass of various kinds of white and greenish-white limestones, sometimes cemented with a red shale paste, but through 500 feet of it, displaying but little cohesion, held together loosely by a gray paste.

The railroad cut was never finished, probably through financial disability, the railroad showing some terrible grades between the two arms of the river.

Crossing the river on to Poplar Neck, massive conglomerate shows along east bank dipping N. 15° W. 50°, which stands the weather well, and seems capable of a high polish.

The railroad then curves through a long cut, averaging 25 feet in depth, composed mostly of a red clay with a few conglomerate boulders in it.

In the middle of the cut there is an outcrop of Potomac Marble, succeeded on the south by red clay, and at end of cut a little red shale.

The red shale extends south along railroad to Seyfert's Forge, near the margin of the map, carrying on its surface many trap boulders derived from the Flying hill dyke. This dyke is exposed on road from T. Peterson's house along river. At first bend of road to the south, red sandstone and shale somewhat altered by trap, are exposed dipping N. 20° W. 37°.

Shale and sandstone are exposed with about the same average dip all along the steep bluff of the hill, down to where the road reaches the level of the river.

It is interrupted in various places by plates of trap inclined apparently to the west at an angle of 45°, resembling in appearance the diorite dyke on other side of the river of which it is really a part.

This latter has a pear-shaped form on the map, with the stem pointing N. W. towards High's woods.

All along the east bank of the river, this rock is frequently exposed, until where river begins to bend to the east. At point of High's woods the dip is apparently S. 35° E. 80°, though owing to its cleavage here as elsewhere along the river, it is difficult to say anything positive about dip. For instance, 300 yards further south, the dip appears to be N. 45° W. 25°, while at the Little Dam, in a quarry

opened in this rock the dip is apparently towards N. E. at an angle of 10°, here largely composed of feldspar and hornblende and of a greenish black color.

At High's woods, where the tow-path winds around the point, the ropes of the canal boats have grooved this trap in several places, which show a high polish, and resist atmospheric influences well.

A shaft has been put down on High's land to prove property, and is said to have struck same body of ore worked in the Island Mine, whose lower workings extend far out beneath the bed of the river.

The north boundary of the red shale and sandstone on the western bank of the Schuylkill has been practically described in the chapters on the Potsdam and limestone.

It everywhere shows the same characteristics as in the eastern portion of the formation, except that its two areas of Mesozoic conglomerate, at the Island Mine and along the head waters of the Cacoosing at the Wheatfield mines, have become so calcareous and fine-grained as to be nothing more than a limestone breccia.

It has frequently been mistaken for No. II and even yet it is familiarly spoken of at the mines as "limestone rock."

It plays the same role here as in the Boyertown mines. Just west of the Island Mine workings two conspicuous hills will be noticed on map, rising prominently out of a low country of New Red shale.

This topography, as well as the boulders on their sides and summits, denotes the presence of trap.

The hills at south limit of map, south of Green Tree tavern, are for the most part composed of trap, from the Schuylkill for 1¼ miles west, tapering in that direction.

This is a continuation of the Flying Hill dyke, and shows frequent layers of altered shale and sandstone between plates of dark-colored trap.

All the remaining country west to the Five Mile House, and south of the Potsdam hills, is mostly shale and sandstone, dipping west of Centre hotel, close to creek, S. 75° E. 60°.

Red sandstone, ferruginous, shows in opposite side of creek in hill—no dip.

Again south of G. W. Bauer's house, and at 400′ contour, red sandstone with pieces of slate in it, dips N. 85° W. 25°.

The country west of small stream heading up to D. Green's house, 1 mile west of Five Mile Hotel, is a mixture of New Red and trap as far as Fritztown Station on the Reading and Columbia RR.

Trap largely predominates over the entire district, though but rarely seen in place.

Boulders of fine-grained trap cover the surface everywhere, concealing, except in a few places, the red shale and sandstone which undoubtedly occupies a considerable area here.

The public road leading up hill from railroad past J. Mark's, J. Dalton's, and J. Hart's houses, is thickly strewn with trap boulders, derived no doubt from the small dykes contained in the various sharp and bold hills common to this part of the county.

One such dyke of far greater importance than its neighbors starts on the public road near valley and extends east along the north side of the Cacoosing creek for ¾ miles. South of it, and extending a little further up valley, occurs the Mesozoic conglomerate, or limestone breccia, holding the magnetic iron ores of the Wheatfield, Ruth and other mines. This is the only instance met with in which trap occurs *north* of the conglomerate.

This whole region is very much disturbed, and the ores show neither regularity in their deposit nor parallelism to the general trend of the rock formations. See Wheatfield mine, page .

Trap is seen east of mine in a little knob, the intervening valley being red shale, as is the country immediately south of the mines.

The conglomerate patch here, about 1 mile long and 200–300 feet wide, will be described in detail in the chapter on the iron ores of this district.

South from here nearly to the Chester county line, there is a wide outspread of the Mesozoic measures, interrupted frequently by trap dykes. But a description of this region will not be in place in this report, which has only to deal with the north edge of the formation as shown on the Index Map.

Chapter VII.

Historical Sketch of the Iron Industry.

Berks county is notable for its early introduction of the manufacture of iron among the industries of the State, and in fact of the United States.

The earliest record of iron works in the United States relates indeed to Jamestown, Va., where in 1619 the Virginia Company, but 12 years after the founding of the first permanent English settlement on the continent of North America, sent skilled workmen to set up three iron works. Early efforts to make iron in America were essayed in Massachusetts in 1643; in Connecticut in 1656; in Rhode Island in 1675; in New Jersey in 1664, and in Pennsylvania in 1692, but these all proved failures. The Proprietary of Pennsylvania in writing to his friends during his first visit to his province in 1683, refers to "mineral of copper and iron in divers places," and offered inducements to Welsh iron-masters to open the mines and begin the manufacture of iron, and carried his plans so far as to dispose of a tract of land in Caernarvon township, where the Jones mine is situated, in 1686, where operations are now carried on by the Phœnix Iron Co.

Instead, however, of being a Welshman, this incipient enterprise was carried on by a German—some say an English smith—named Thomas Rutter.

In Mrs. James' "Memorial of Thomas Potts, Jr.," we read that Rutter was supposed to have come over with William Penn, and after living some time near Germantown, Pa., in 1717 he removed "40 miles up the Schuylkill, to the very frontiers of civilization, in order to work the iron mines of the Manatawny Region."

Thomas Rutter's tract on the Manatawny, which he got

by purchase, is now Colebrookdale, Amity, and Douglass townships, containing the valuable ore tract at Boyertown in the first-named township.

In the year 1717, the first forge in the Province of Pennsylvania was erected by Rutter and American iron exported to England.

The site of this enterprise, known as "Pool Forge," was on the Manatawny about 3 miles above Pottstown, not far above the Glasgow Forge, and the remains of the old dam are said to be still visible.

It was probably built about 1719–1720 and is supposed to have been the scene of the Indian massacre in 1728. Meanwhile, Thomas Potts became engaged in developing the iron mines in 1723, though these had been worked for several years on the Manatawny, Schuylkill, and French creek, of which an interesting account will be found in Mrs. James' memoir.

The expense of building a furnace then was estimated at £500 and two square miles of woodland was deemed sufficient to feed the furnace.

In 1734 pig-iron sold for £6 and bar-iron for from £10 to £16 per ton, not counting freight, &c., £1 to £2 per ton to England.

Rutter built both forges and furnaces for smelting his ore, associating with him his son-in-law, Samuel Savage, and Samuel Nutt, the latter applying himself especially to the development of the French creek region.

Another Pool Forge four miles further up the Manatawny was known to have existed, but it was probably built afterwards.

The first *furnace* was supposed to have been erected by Rutter near the Pottstown bridge on the Schuylkill, though others assign this honor to James Lewis and Anthony Morris, and locate the site of their works at Colebrookdale, Berks county.

Mr. James M. Swank in his "Statistics of the Iron and Steel Productions of the United States" for the 10th census, (1881,) practically settles the matter, where he says: "The truth and history will not be violated if we award ungrudg-

ingly to Thomas Rutter the honor of having erected the first blast furnace, as well as the first forge in Pennsylvania."

He, moreover, adds in the same report that this furnace was "undoubtedly Colebrookdale furnace, which was erected about 1720, on Ironstone creek, in Colebrookdale township, in Berks county, about 8 miles north of Pottstown, $\frac{3}{8}$ of a mile west of Boyertown, and about 200 yards from Colebrookdale railroad. Plenty of cinder marks the exact site to-day. A large grist and saw-mill (Jacob Morey's mill) stands about 100 feet distant."

Indeed, until quite recently further evidence of this site could be had from the large pile of ore (probably 1000 tons) that still remained there, and which Mr. Morey hauled to Boyertown and sent it thence to the Warwick Iron Company's Furnace at Pottstown.

Some of this ore I saw myself on the wharf at Boyertown. It was a dull reddish black powder, similar to that mined in some of the red hematite mines around Zionsville and Shimersville in Lehigh county, and was no doubt little thought of at the time.

It may have been either screenings of the old charcoal furnace ores, as Mr. Cook, of Warwick furnace, suggests, which owing to its fineness would be difficult for any cold-blast furnace to smelt to-day ; or it may have been the top covering to some of the hard ores at Boyertown, taken out as useless surface croppings and oxidized by long exposure. It bears a strong physical resemblance to the Siesholtzville soft magnetite, and Mr. E. F. Cook writes that his recollection of an analysis made recently showed Iron 42 to 45%, alumina 10%, silica 18%.

The company which built Colebrookdale furnace appears to have been composed of Thomas Rutter, James Lewis, Anthony Morris, and others, Rutter owning two thirds interest, as is shown by his will dated Nov. 27, 1728.

Swank continues : "The iron industry of Pennsylvania may be fairly said to have been established on a firm foundation at this period. In 1728-29 the colony exported 274 tons of pig-iron to the mother country. The production

of a Pennsylvania furnace at this time was about two tons of iron in twenty-four hours."

Seven years afterwards, or in 1735, David Jones, a Welshman, occupied a tract of 1000 acres of land in Caernarvon township, Berks county, which a half a century before had been sold to a Welsh company, and soon became one of the foremost iron masters of his day.

The following furnaces and forges are all known to have been erected prior to the Revolution in the Manatawny region:

Mt. Pleasant furnace* and forge, Spring forge, Colebrookdale furnace and forge, Amity forge, Rutter's forge, Pool forges 1 and 2, Pine forge, Little Pine forge, and McCall's forge. Manatawny furnace and forge are also mentioned in old papers, but are thought to be identical with Colebrookdale. All these were carried on and owned by the united families of Rutter and Potts.

With the exception of Pine Forge and McCall's, afterwards Glasgow Forge, built in 1725 on the Manatawny, most, if not all of the above named works have been abandoned and destroyed.

Pine Forge, which still stands on the Manatawny, 5 miles above Pottstown, close to the Douglass-Amity township line, is probably the oldest iron works in Pennsylvania.

It was built about 1740, by Thomas Potts, Jr., and to-day marks the wonderful progress in iron manufacture. It is owned by Jos. L. Bailey, though worked under a lease by Bailey & Shoemaker.

It has been noted for its high grade of *plate iron* for locomotives and stationary boilers, which is its specialty. A rolling mill was started in 1845, which, when running full,

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* An interesting record is given in Mrs. James' book of a blast of this furnace, situated on Perkiomen creek near the present site of Barto, about 13 miles above Pottstown. Built 1738-40. First blast, commencing Oct. 12, 1783, hove off, Dec. 11:

		T.	*Cwt.*	*Qr.*	*Lb.*
Made the said blast, . .	Pigs, ...	85			
	Country castings, .	6	1	2	2
	Forge castings,		7	3	6

This is one of six blasts running on to July 20, 1741, which shows a total of 470 days, and a product in round numbers of 690 tons, or about $1\frac{1}{2}$ tons a day.

gives employment to 50 men. Messrs. Bailey & Shoemaker own another new and handsomely equipped mill erected in 1881-'82 at Manatawny station, Colebrookdale R. R., which has a rather larger capacity. Each mill has two furnaces.

Among other historical iron works within the county limits, I might mention Charming Forge, near Womelsdorf, on the Tulpehocken, built in 1749, and still in operation in 1882.

Mary Ann furnace, in Longswamp township, afterwards called Trexler's furnace, was in existence as early as 1762, when it was owned by Geo. Ross and Geo. Ege. It was sold to Reuben Trexler in 1808, and operated by him till 1837, and from then till 1869 by Horatio Trexler in a continual blast except for repairs.

The first coal stoves in the State were made there by Mauch Chunk (?) coal, and afterwards the furnace was run on stove plates and pig metal, and entirely on the latter from 1860 to 1869.

Furnace was 30 feet high, with a 7-foot bosh, but is at present almost entirely dismantled.

Previous to 1797, Jacob Lesher had erected a furnace in District township, near Lobachsville, which was abandoned about 1814.

Other historical iron enterprises in the mountain district were *Sally Ann furnace*, built in 1791, in Rockland township, about 2 miles S. E. Bower's station, E. P. R. R.

After having been idle for many years it was refitted in 1879, and is now in operation under the Rockland Iron Co. limited, of Douglassville, Berks county. Mr. Franklin Morett was the manager. Using mostly limonite hauled from Bower's station, and producing No. 1 charcoal iron from 30 to 36 tons per week, at $35 per ton. Steam was recently introduced into the furnace, which has a 31-foot stone stack and an 8½-foot bosh.

Grade of iron Nos. 1 and 2, used for blooms and car wheels. Cold blast charcoal furnace, two tuyeres.

Oley charcoal furnace, owned by Clymer Iron Co., Abraham Schweitzer, manager. Situated in Oley township, about midway between Pricetown and Friedensburg; on

Furnace creek. Built in 1780 by David Udrée. Plenty of wooded hills surround the furnace, giving a copious supply of charcoal.

The furnace has long been famed for the excellent quality of its car-wheel iron. East Penn limonites are used, mixed with soft magnetite from Clymer open cut (see page 270) and Weaver Mine limonite (see page 365 ;) the Udrée bank limonite, otherwise advantageously located for use here, is too cold-short to be utilized (see analysis of Udrée ore, page 363.)

Stack 30′, round hearth 26″ at bottom and 36″ at top, and 5′ high. Bosh is 6″ slope to the foot and 3′ high.

"Inwall" 8′ at foot, drawn into 17″ at top. An upright high pressure Weimar blowing engine 25 h. p., supplies cold blast, through one 12″ tuyere, water cooled with 2½″ nozzle.

Engine is run at 45 revolutions to the minute, one cylinder, 12 inch stroke.

January 2, 1882, average charge and cost per ton No. 1, foundry iron was

150 bushels charcoal @ .10, ...	$15 00	
2¾ tons of ore @ $3.50, ...	9 62	
¾ tons limestone @ $1.00, ...	75	
Labor at furnace, ...	3 00	
Sundries, ...	1 00	
	$31 37	say $31 00

Yield of iron is about 38 per cent. to an analysis of 42 per cent. ore. Annual production about 1800 tons.

The Oley forge, on Manatawny creek, built by Udrée in 1780, was in operation till 1856, and the *Green Tree forge*, in Rockland township, in 1770.

William Bird, an Englishman, was also prominent in the establishment of early iron enterprises in the county. According to 10th Census Report (Swank,) page 102, "he built a forge in 1740 or 1741 on Hay creek, near its entrance into the Schuylkill, where the town of Birdsboro now stands. In 1759 he built Hopewell furnace, on French creek, Union township, which is still in operation and still using charcoal. In the same year he built New Pine forge, in the same township. In 1760 he built Roxborough furnace,

Heidelberg township, subsequently called Berkshire furnace * * * * * * * * *

Mark Bird, a son, built a rolling and slitting mill and nail factory at Birdsboro, about the time of the Revolution; also Spring forge in Oley, and Gibraltar forges in Robeson township."

Joanna furnace, on Hay creek, was built as early as March, 1793. It is still in operation, and still uses charcoal.

Reading furnace, 2 miles east of Womelsdorf, was built in the same year by George Ege, on the site now occupied by the Robesonia furnaces.

The following statistics, taken mainly from Mrs. James' memoir, Swank's 10th Census Report, and the annual Report of the Board of Trade, Reading, Berks county, are inserted to show the extent and development of iron making in the county.

In 1788 Pennsylvania produced 5000 tons pig-iron, 36,000 tons bar-iron, 1000 tons of castings at a valuation of £100,500, £1 pound being equivalent to \$2 66 of Pennsylvania currency.

From the prominent position Berks county occupied in the incipient stages of the iron industry a large proportion of these totals should be credited to her account.

In 1880 the production of iron and steel in Pennsylvania had swelled to the enormous total of 3,616,668 tons, of which amount Berks county contributed 213,580 tons iron, being exceeded by Allegheny, Lehigh, Northampton, Cambria, and Dauphin. No steel is produced in the county.

To produce this amount the following furnaces merit mention. The list is taken from the latest official sources, principally the annual reports of the Secretary of Internal Affairs of the Commonwealth of Pennsylvania, Industrial Statistics 1880-81, and the Secretary of the American Iron and Steel Association, and is for the year ending Dec. 31, 1881.

Bechtelsville furnace, Bechtelsville Iron Co., Bechtelsville, on the Colebrookdale Railroad 15 miles E. of Reading, 1 stack built 1875, produced 6,104 tons, foundry and grey forge, annual capacity 12,000 tons, hot-blast, anthracite and coke.

Keystone furnace, Keystone Furnace Co., Reading, on the Philadelphia and Reading R. R., 2 stacks built 1869 and 1872, produced 16,793 tons, A. No. 1, annual capacity 20,500 tons, hot-blast, anthracite.

Monocacy furnace, Monocacy Furnace Co., Monocacy, on the Philadelphia and Reading R. R., 10½ miles S. E. of Reading, 1 stack, produced 6,185 tons foundry iron, capacity 8,129 tons, hot-blast, anthracite. This furnace was originally built at Hopewell in 1852, and removed to Monocacy in 1854.

Moselem furnace, Moselem Iron Co., Moselem, on the Schuylkill and Lehigh R. R., 13 miles N. of Reading, 1 stack, produced 3,827 tons, foundry iron, capacity 4,000 tons, hot-blast, anthracite. This furnace was built in 1823 and rebuilt in 1872.

Robesonia furnace, Ferguson, White & Co., Robesonia, on the Lebanon Valley R. R., 12½ miles W. of Reading, 1 stack built 1845, rebuilt 1858, produced 9,000 tons Bessemer iron, capacity 10,000 tons, hot-blast, anthracite.

Rockland furnace, 16 miles N. E. of Reading, and about 3 miles from Bower's on the East Pennsylvania R. R., 1 stack, capacity 1,000 tons charcoal. Out of blast Dec. 31, 1880.

Temple furnace, Temple Iron Co., Temple Station, East Pennsylvania R. R., 5 miles N. of Reading, 1 stack, built 1867, produced 5,733 tons foundry iron, capacity 10,000 tons, hot-blast, anthracite.

East Penn furnace, Philadelphia and Reading Coal and Iron Company, Lyon's Station, East Pennsylvania R. R., 15 miles N. E. of Reading, 2 stacks, built 1874-5, capacity 10,000 tons, hot-blast, anthracite. Out of blast.

Mount Laurel furnace, Clymer Iron Co., near Temple Station, East Pennsylvania R. R., 5 miles N. of Reading, 1 stack, produced 2,336 tons, foundry iron, capacity 4,013 tons, hot-blast, anthracite. This furnace was built in 1836, using charcoal, rebuilt in 1847, and changed to anthracite 1873.

Oley furnace, Clymer Iron Co., Oley, 9 miles E. of Reading, 1 stack, built in 1770, produced 1,800 tons, car-wheel iron, annual capacity 1,800 tons, cold-blast, charcoal.

Leesport Furnace, Leesport Iron Co., Leesport, on the Philadelphia and Reading R. R., 8 miles N. of Reading, 1 stack, built ——, produced 10,766 tons, foundry iron, annual capacity 10,800 tons, hot-blast, anthracite.

Joanna Furnace, L. B. Smith & Co., Joanna Furnace P. O., 18 miles S. of Reading, on the Wilmington and Northern R. R., 1 stack, built in 1792, rebuilt in 1847, produced 1,240 tons charcoal iron, capacity 1,500 tons, cold-blast, charcoal.

Reading Iron Works Furnace, Reading Iron Co., Reading, on the Philadelphia and Reading R. R., 2 stacks, built 1854 and 1874, produced 13,860 tons Nos. 1, 2 and 3 forge iron, capacity 20,000 tons, hot-blast, anthracite and coke.

Henry Clay Furnaces, Eckert & Bro., Reading, on the Philadelphia and Reading R. R., 2 stacks, built 1842, produced 15,174 tons, foundry and forge iron, capacity 18,000 tons, hot-blast, anthracite.

Hampton Furnace, E. & G. Brooke Iron Company, Birdsboro, on the Wilmington and Northern R. R., 11 miles S. E. of Reading, 1 stack, built in 1846, produced 254 tons, capacity 1,000 tons, hot-blast, charcoal.

Keystone Furnaces, E. & G. Brooke Iron Company, Birdsboro, on the Philadelphia and Reading and Wilmington and Northern R. R., 9 miles S. E. of Reading, 3 stacks, built in 1853, 1871 and 1873, produced 16,801 tons forge iron, &c., capacity 40,000 tons, hot-blast, anthracite.

Hopewell Furnace, Clingan & Buckley, near Douglassville, on the Philadelphia and Reading R. R., 13½ miles S. of Reading, 1 stack, first built in 1759, produced 1,000 tons, car-wheel iron, capacity 1,000 tons, cold-blast, charcoal.

Topton Furnace, Topton Iron Co., Topton, on the East Pennsylvania R. R., 18½ miles N. E. of Reading, 1

stack, built 1873, produced 7,817 tons, foundry iron, capacity 8,000 tons, hot-blast, anthracite.

Kutztown Furnace, Kutztown Iron Co., Kutztown, on the Allentown Branch of the East Pennsylvania R. R., 23 miles N. E. of Reading, 1 stack, built 1875, produced 7,145 tons, foundry and forge iron, capacity 7,200 tons, hot-blast, anthracite.

Maiden Creek Furnace, Spang & Co., Lenhartsville, on the Schuylkill and Lehigh R. R., 19 miles N. of Reading, 1 stack, built 1854, capacity 2,000 tons, product car-wheel iron, cold-blast, charcoal.

Union Furnace, H. B. Fisher & Co., near Hamburg, on the Philadelphia and Reading R. R., 18 miles N. of Reading, 1 stack, capacity 1,000 tons, product car-wheel iron, cold-blast, charcoal.

Mount Penn Furnace, near Reading, Wm. M. Kauffman & Co., by wagon road, 3 miles W. of Reading, 1 stack, built in 1830, capacity 1,500 tons, cold-blast, charcoal.

The following is a list of the recently abandoned furnaces in Berks county reported in 1880:

Mary Ann Furnace, Longswamp, Horatio Trexler, charcoal, built 1797. Out of blast since 1869.

Paradise Furnace, Reading, Horatio Trexler, built in 1821, charcoal.

Sally Ann Furnace, Bower's Station, Daniel S. Hunter, built in 1791, charcoal.

These furnaces, aggregating 27 stacks, employed 905 persons; $298,070 were paid in wages, and produced 126,833 tons of pig-iron.

The average amount per ton paid in wages in Berks was $2 35 as against an average of $2 96 for the entire State.

Berks county, in addition to its blast furnaces, had five (5) out of the nineteen bloomaries in the State in 1880. On December 30, 1881, four bloomaries were in operation.

The following is the list of those in Berks county:

Charming Forge, Womelsdorf, 15 miles from Reading, on the Lebanon Valley R. R., W. & B. F. Taylor, produced 72 tons, blooms and hammered bar iron, capacity 1,000 tons.

Exeter Forge, Jacksonwald, 4 miles from Reading, by road, Morgan J. Althouse, produced 240 tons of blooms.

Knauer & Kauffmann's Forge, Knauer's P. O.

Mount Airy Forge, Shartlesville, Thomas E. Williams, built 1840, water power, product, blooms.

North Kill Forge, Shartlesville, product, blooms. Idle for several years.

Schuylkill Forge, B. F. Morret, Douglassville, produced 1,403 tons.

Simon Seyfert & Co., Gibraltar, 5½ miles S. of Reading, and 1 mile from Gibraltar Station on the Wilmington and Northern R. R. No report.

The aggregate extent, value and importance of the metallurgical industries of Berks in 1880, were as follows:

Establishments, 45; capital, $6,864,783; hands employed, males, over 16 years, 3,915; children and youth, 216; wages paid during the year, $1,488,077; value of materials, $7,658,112; value of products, $10,178,612.

CHAPTER VIII.

The Magnetic Iron Ores.

These ores are only found along the South Mountain belt in Berks county—that is, on the slopes or at the southern margin of the highlands, east of the Schuylkill; and in the prolongation of the line of older rocks across the river, below Reading, into Chester and Lancaster counties.

The iron ores of the limestone belt of the valley are of a different kind, (*limonite* or brown hematite,) and will be described in a chapter by themselves.

Magnetite pure is a compound of iron and oxygen, in the proportion of 72.4 to 27.6. Magnetic iron ore is a mixture of *magnetite* with more or less earthy matter, chiefly silica, alumina, lime, magnesia, potash, soda and manganese, in the forms of quartz, feldspar, hornblende, and occasionally mica. Absolutely pure magnetic iron ore, therefore, cannot

yield the iron worker more than 72.4 per cent of pure iron. The very best ores in the market yield from 66 to 68 per cent. What is called *very good ore* yields less than 2 tons of iron to 3 tons of ore. *Ordinarily good ore* runs something over a ton of iron to two tons of ore.

Some magnetic ores contain so much *sulphur* as to make red-short iron; others, so much *phosphorus* as to make only casting iron.

Manganese is a desirable ingredient, when sulphur and phosphorus are absent, because it makes a magnetic iron ore valuable to the Bessemer works. The soft ore of the Clymer open cut in Ruscombmanor township, for example, contains 7.5 per cent of manganese.

Magnesian limestone is a frequent constituent of the magnetic ore beds of the range along the south foot of the South Mountains, at the edge of the Mesozoic; but the magnetite ore beds of this range belong to the Mesozoic Conglomerate rocks rather than to the Azoic mountain rocks.

The magnetic ore beds of the South Mountains are *regularly interstratified with the gneiss beds*, and are evidently original sediments, of limited extent, lens-shaped, swelling at the center, and tapering to an edge, both sidewise and downwards, and often suddenly pinched out by the pressure to which the Azoic formation has been subjected. Numerous partial pinchings are met with in mining. (See Fig. 11, page 191.)

These irregularities are especially great in the case of the magnetic ore beds connected with the Mesozoic Conglomerate: great swellings or bunches of ore occurring, which sometimes measure 50 feet across, and in a short distance the ore bed will be thinned down to a few inches. A fine example of this may be seen in the lowest level of the Warwick mine at Boyertown. Here a pillar of ore has been left standing 80 feet high by 30′×40′ at the base.

The whole of this effect is not produced by pressure. Much of it is due to the shape of the original deposit. This is seen by observing how the ore at the edges of the "ore body" *gradually changes into rock;* and this change

is so imperceptible that one can hardly say where the ore ceases and the rock begins. A good example of this, as well as of the bunching, may be studied in the Rock Mines of the Rittenhouse Gap district, in Longswamp township, (See Fig. 12, page 245,) where both phenomena are well displayed—the irregular thickening and thinning of the ore-leads, and also the fading away of the ore into the rock. While the average thickness of beds in this group is hardly over *six feet*, they sometimes thicken to 10, 20, and even 30 feet, and thin down to a few inches. In the open cuts which trench the whole north flank of the hill this can be plainly seen, as well as the blending of ore and rock.

Practical miners and others commonly still hold the old erroneous opinion that magnetic iron ore beds have issued like lava from the interior of the earth, and urge two principal arguments for this opinion, viz. 1. That the ore body looks as if it filled a fissure with irregular walls; and 2. That trap dykes accompany the ore in many of the mines. Now, whatever may be thought of the formation of other magnetic ore beds, it is very certain that those of the South Mountains *are not injected veins*, but are *true sedimentary beds*, interstratified with the gneiss layers.

As to the magnetic ore beds of the Mesozoic conglomerate range I have seen unmistakable proofs of their stratification with the limestone beds; and in the museum of the survey a specimen from the Boyertown Warwick mine consists of three parallel layers of ore averaging an inch in thickness, separated by layers of limestone each 3 or 4 inches thick.

If these magnetic ore beds, then, be not ejections of melted iron ore from unknown depths, but merely very ferruginous beds among the layers of gneiss, they cannot be considered true mineral veins; nor can they be expected to always increase in size downward, nor to descend to unlimited depths. What happens to a magnetic ore bed when followed along the surface will sooner or later happen in sinking upon it—it will feather out. At what depth no one can predict. That must depend on the shape of the

original deposit. In the Rittenhouse Gap district the bottom edge has been (to all appearance) reached at depths of from 100 to 150 feet. On the other hand, at Boyertown the ore seems to keep its surface thickness at a depth of nearly 600 feet.

The *pitch of the ore-bodies* in a magnetic ore bed is not the same thing as the *dip of* the bed itself. The *general dip* of all the rocks (and therefore of the ore beds) is towards the S. E. The *general pitch* of the ore-bodies in the beds of Berks county is towards the N. E.

This is not so evident a fact in Berks county as in New Jersey, merely because exploitation has not been carried on in as great a number of places and to as great an extent. But wherever there is a chance to see the *pitch of the ore* it is seen to be N. E. In other words, when an outcrop of ore is exposed along the surface of the ground, between gneiss rocks dipping S. E., the north-eastern edge of the ore is found to sink, sloping underground eastwardly. The cause of this fact is not well understood, but the fact is of importance to the landowner as well as to the miner.*

Folds in the magnetic ore beds are additional proofs, if any were wanted, that they are not ejections from below, but sedimentary strata. Such a *fold*, in the shape of a closely-compressed *synclinal trough*, has been actually worked out at the Hurd mine in New Jersey, as represented in cross-section in the N. J. Geol. Report of 1868. I reproduce this section in Fig. 13.

The Hurd mine slope track is laid down on the bottom rock of the fold, and the breasts show that the ore rises vertically on one side of the fold, in a solid bed, to the surface. On the other side of the fold it also rises at a steep angle to the surface, but divided into several beds.

A similar structure is said to exist in the Durham mines in Bucks county.

No *anticlinal* or *synclinal folds* have yet been discovered in the Berks county mines; but if the gneiss rocks dip all

*A "chimney" structure somewhat analogous to this characterizes the precious ores of the West, and is explained by reference to the shifting of the waved walls of fissures.

Fig. 13. Hurdtown iron mine in N. Jersey

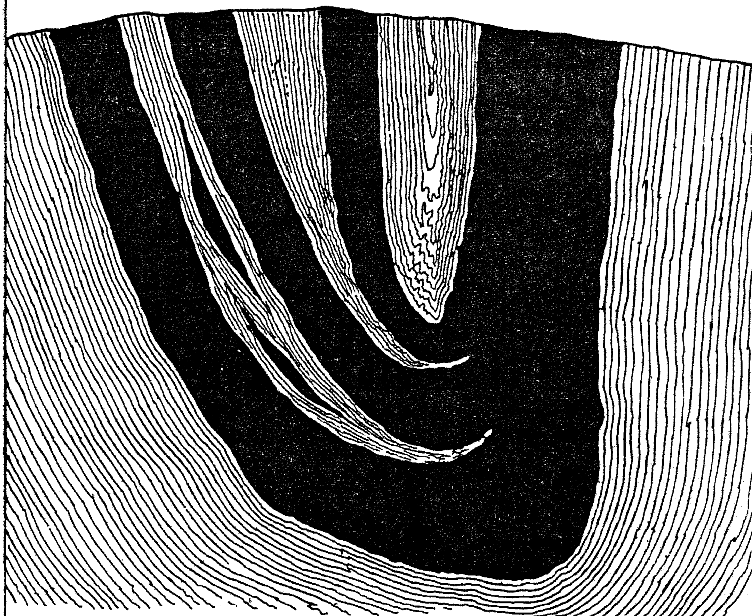
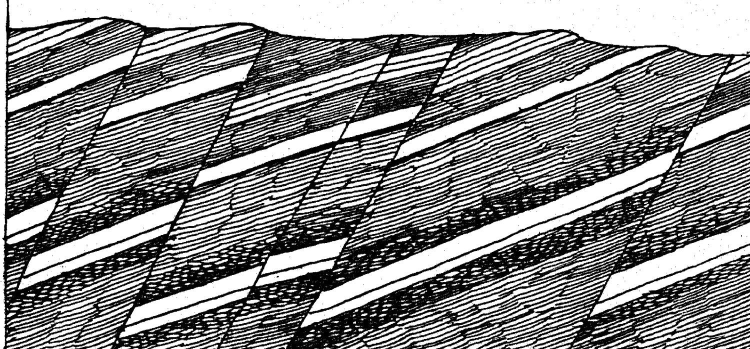


Fig. 14 Theoretical diagram of faulted rocks.



one way, towards the south-east, because of the tightly-crumpled condition of the country, we may expect sooner or later to find magnetic ore beds taking part in this crumpling.

Thus far all the Berks county mountain ore beds are opened on one side of a ridge and do not appear at the surface on the other side. But this may be owing to their limited extension downward. It is certain that the magnetic ore beds of the South Mountains have shared in all the complications to which the enclosing gneiss rocks have been subjected.

Faults, cross cracks and downthrows or upthrows occur in several of the more extensive mines; and future exploitation will probably show them to be numerous in the district. In the Gabel mine, for instance, a five-foot ore bed is faulted several times through 25 feet of rock. In the lower levels the same ore is in one body, called the "Black ore vein." A series of faults of the downthrow kind is illustrated by Fig. 14.

The *slips* of the miners are really such faults as have been just described, but so small as to amount to only a few inches. Slips are numerous in the Boyertown mines. The sides of these slips show the motion under pressure by their polished, shining surfaces, called "*Slickensides*."

Horses, or wedge-shaped masses of limestone or syenite, are encountered by the miners, to whom they are both expensive and troublesome.

The *magnetic ores* of the district are all black, and give a black streak; but while some of them are hard and massive, with a metallic luster, others (like the Clymer and Siesholtzville) are soft earthy powders filling the bed. They all show more or less magnetism; but few of them are crystallized. Iron pyrites, either in bunches or in grains, is common in the beds, and their ores must be roasted. Phosphorus, on the contrary, seldom troubles the ores of the district.

Analyses of ore from various mines have been made in the laboratory of the Survey at Harrisburg, by the chemist of the Survey, Mr. McCreath, and will be found on

subsequent pages of this report. Mr. McCreath made his own samplings in person at the more important mines, and states the character of each sample on the face of the analysis. In other cases I selected and transmitted my own specimens to him at Harrisburg.

Other analyses are given, which have been furnished by furnace owners and operators.

The *output of ore* from the Berks county magnetic ore mines is small compared with that of the same range through New Jersey and New York; but the mining may be said to be yet in its infancy.

The aggregate thickness of all the known beds is insignificant as compared with the total amount of Azoic rocks in which they are contained. Yet new beds are being frequently opened, which render the importance of the strata very great. Indeed, many of the old openings, worked on the ruinous contract system, and consequently abandoned before being fully tested, need only energy and a little capital and improved machinery to turn out a handsome amount of ore; for it seems ridiculous that in a region of so much promise, and so greatly dependent upon this industry for its sustenance, there are but two mines suitably equipped with machinery to do their work efficiently.

It is well-nigh impossible to locate the many recent ore openings, though this has been done in every known instance during the continuance of the instrumental survey of the mountains.

The number and position of these openings can be judged from an inspection of the carefully prepared topographical sheets accompanying this report, as well as from the colored Index map.

In all of Mr. McCreath's analyses the ore was dried at 212°F, and under date of Dec. 24, 1882, he writes that "some of the soft magnetites will carry from 5 to 10% hygroscopic moisture."

He also calls attention in his letter to the few analyses giving "silicious matter" instead of silica, in which cases solution in acid gave a perfectly white residue, and fusion was not thought necessary.

It must be remembered in comparing the various analyses of any one mine that these magnetic ores show no constancy of composition whatever, and will vary in every month of the year to some slight extent, and therefore a disagreement in result does not necessarily vitiate an analysis.

In describing the ore outcrops and mines no attempt will be made to arrange the data along geographical or geological lines, for with our present amount of knowledge such an attempt would probably fail. They will, therefore, be described in the following pages by townships, each under its special title, and with all the references I can make to local objects of interest to the people of Berks county, to whom I here return my thanks for the signal kindness with which they have tendered their assistance in my researches.

Detailed Description of mines and outcrops.

Magnetic Ore Mines of Longswamp Township.

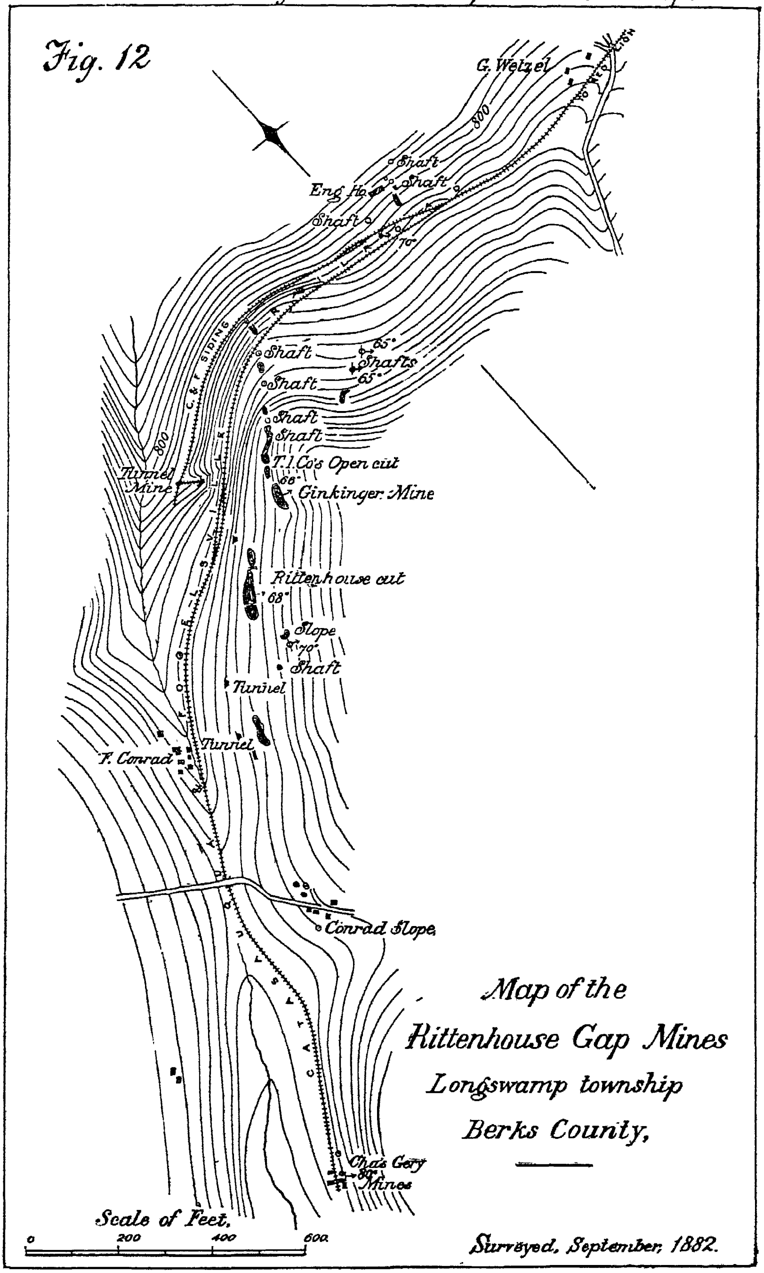
In the past, Longswamp township has occupied a very prominent position in the production of iron ore, and at one time there were fully 100 mines in operation, with an annual production of half a million tons. Though much activity is still evinced in working the limonites of the Great Valley, the magnetic mines in the Azoic rocks have been largely abandoned and the consequent production greatly curtailed.

1st. Rittenhouse Gap District.

This is probably one of the oldest ore-producing districts in the county. The various mines, productive and non-productive, were instrumentally located during the progress of the topographical survey in 1879; and with the assistance of Mr. Edwin Mickley, of the Thomas Iron Company, a revised map of the region was made in 1882, and is shown in Fig. 12, page 245.

The mines of this district are familiarly known as the

Fig. 12


G. Welzel
800
Shaft
Eng. Ho.
Shaft
Shaft
70°
C. & F. SIDING
Shaft
65°
Shafts
65°
Shaft
Shaft
Shaft
800
T. I. Co's Open cut
Tunnel Mine
68°
Ginkinger Mine
Rittenhouse cut
68°
Slope
70°
Shaft
Tunnel
F. Conrad
Tunnel
Conrad Slope
Chas. Gery Mines
Map of the
Rittenhouse Gap Mines
Longswamp township
Berks County,
Scale of Feet.
0
200
400
600
Surveyed, September, 1882.

"Rock Mines," a name derived from the original "Rock Mine" on the Rittenhouse property as well as from the generally hard character of the syenitic gneiss gangue found in all these openings. Considerable land is still held here by the Rittenhouse family, and the position of the old "Rock Mine" is shown in the cut.

Its record is an old one.* Prior to 1785 the mine was worked by the Mayberrys, who used the ore in the furnace at Greenlane, Montgomery county.

From 1785 to 1809 Jacob Lesher, one of the pioneer iron masters of Berks county, worked the mines, and used the ore in the old Mary Ann Furnace, now abandoned, and located about 2 miles distant, in the valley.

Mr. Reuben Trexler, his son-in-law, purchased these mines and the furnace, to which he gave his name, and operated the mine successfully from 1809 to 1846.

In the year 1861 Mrs. Lucinda Rittenhouse, who inherited this mine and about 44 acres of land from her father, Reuben Trexler, leased the premises to the Thomas Iron Company for 20 years, which lease expired in 1882. This was the first lease on the premises, and the small royalty of 25 cents per ton was agreed upon, in consideration of the Thomas Iron Company agreeing to extend the Catasauqua and Fogelsville R. R. to Rittenhouse Gap.

During their lesseeship the Thomas Iron Company sank several shafts and opened several open cuts in conjunction with their own property to the east.

The mine when visited in the summer of 1882 was still idle, no new lease having been taken out.

It shows a cut 200′ long—150′ on Rittenhouse property and 50′ on Thomas Iron Company land, located on the second of four ranges in this region. A small dyke 4′ thick, similar to that found in the Tunnel mine, serves to divide the properties, a similar one occurring further west in the Rittenhouse property. The mine was originally worked as an open cut to the depth of about 60 feet, from the bottom

* Obtained mainly from Mrs. Lucinda Rittenhouse, through Miller D. Evans, Esq., of Pottstown.

of which shafts have been sunk, 100′ on T. I. Co. land and 150′ on Rittenhouse property.

The ore occurred as a lenticular-shaped body, averaging 10′ to 15′ thick, though swelling greatly in the center, a characteristic of all the ore bodies in the region.

East and west the ore pinched out entirely, or more correctly, came to an abrupt end in rock.

Foot and hanging wall here show a fine-grained granitoid gneiss with a flesh-colored feldspar; of smooth texture at foot, but much jointed and broken in hanging wall, and with south dipping cleavage planes.

The dip shows about S. 40° E. 68°, though *decreasing* lower down in mine, another *characteristic feature* in all these openings.

The following are two analyses of this ore; No. 1 sampled and analysed by H. G. Detweiler, Bethlehem Iron Co.; No. 2 sampled at mine, and analysed by P. W. Shimer Nov. 28, 1878:

	(1)	(2)
Fe_3O_4,		57.15
Silica,	43.170	39.71
Phosphorus,	.016	.048
Metallic iron,	39.268	41.38

Before speaking in detail of the various openings it may be as well to say something of their general character.

All the openings show a foot and hanging wall of hard syenitic gneiss, made up of small crystals of pink and white feldspar, grains of white quartz, and occasionally a few grey mica scales.

The general appearance of the rock is quartzose, varying in color from a grey to a dark pink, the ore being generally intimately associated with rock, as the analyses will show. Indeed, they imperceptibly grade into one another, and good judgment and long practice alone will tell the dividing plane between ore and rock.

A universal south-east dip prevails, the ore occurring in four nearly parallel ranges, all dipping from the north flank *back* into the hill.

The prevailing outcrop dips are very steep, from 70° to 80°, though declining sharply to perhaps 30° in some of

the deeper mines, suggesting a possible basin beneath the center of the hill and structure similar to that shown in Fig. 13, page 241.

No openings have as yet been made on the south side of the hill, though ore has been found far around on the south-east flank.

The steep dips at the surface made the outcrop a prominent one here, rising up from the hillside in nearly vertical columns of ore 20′ thick and fully that high.

All this has given place to gaping holes, and the general idleness of the district now presents a very desolate picture.

The contract system of mining has also done its share towards ruining the property, for it acknowledged no future, and worked only for a certain end of taking out all the available cheap ore as quickly as possible, regardless of the eventual condition of the mine.

The iron percentage of these mines will not average over 40 or 45, and they would not be worked at all (owing to their enormous quantity of silica) if it were not for the fact that they are almost entirely free from sulphur and phosphorus, and can be used, consequently, for Bessemer iron.

They are largely mixed with the rich foreign ores, and some of the native earthy limonites, and so produce a good quality of iron.

One by one these mines have been abandoned, until on September 22d, the date of my visit, the *Tunnel Mine* was the only one in operation. The ore in this mine is probably on the 4th range of ore, as will be noticed further on. It is owned and worked by the Thomas Iron Company, of Hokendauqua. The ore is reached by a tunnel 900 feet long, driven into the north flank of the hill at the end of the C. & F. R. R. siding, on the 850′ contour, and close to the stream flowing down through Conrad's farm.

This mine was opened about 50 years ago, and has furnished a large quantity of ore to the old charcoal furnaces of the district. It was re-opened in 1879 during the boom by the T. I. Co., and at present, with Wm. Donsen as boss, it furnishes about 25 tons a day to that company. Twenty-two (22) men are employed there.

The tunnel was driven through hard quartzose gneiss, and nowhere through the 900 feet does it show any signs of cutting the ore of the other ranges, showing that they must either have pinched out before reaching the level of the tunnel, or else the dips must have flattened greatly.

There were two beds struck in the tunnel, one at 900′, varying from 8′ to 20′ thick; the second, parted from the first by 14 feet of rock, averaging 10′ to 12′. Both dip from 50° to 60° to the southeast, and each shows at foot wall about one foot of gray ferruginous micaceous gneiss—"ore rock"—regularly stratified, with scales of gray and black mica, and thin seams of ore.

The occurrence of this rock, called "soft ore" by the miners, is very marked in this mine, though not particularly noticeable elsewhere in the mountain. The foot rock proper is almost a true granite, with crystals of pink feldspar; hanging wall is the same—very hard and requiring but little timbering.

Gangways have been driven east 150′ and west 125′ along the strike, and the ore is run out on a small track crossing 20 feet over the C. & F. R. R. siding, where it is dumped (after sizing and picking) directly into the cars of the T. I. Co., and taken to their furnaces at Hokendauqua.

It costs 15 cents per ton to load, which is included in the $1 50 per ton for mining.

All the ore has to be blasted on account of its great hardness, and consequently can not be mined economically when largely mixed with rock.

There is a decided pitch to the N. E. in this mine, which is likewise visible in the openings on the various ranges.

Two noticeable dykes occur in this mine, first met with at 900 feet, each being from 1 to 6 feet thick, and cutting the beds at right angles.

Their dip is 70° to south-west, and, though they cut off the ore, they do not seem to displace it, as ore occurs on either side of it at the same level.

It is familiarly called "soapstone" by the miners, and seems to be very persistent.

It decomposes to a bluish-gray clay, with just enough

consistency to stick together and retain its original lamination.

A piece of this decomposed portion sent to Dr. Edgar F. Smith of Muhlenberg College, and analysed under his direction by Mr. Benjamin Sadtler, Jr., showed:—

SiO_2,	37.09
Al_2O_3,	44.71
FeO,	11.96
Fe_2O_3,	1.93
MgO,	1.75
MnO_2,	trace.
CaO,	3.02
Total,	100.46

Its clay-like character when decomposing suggests the large percentage of alumina, and its coloring matter is iron.

An analysis of the ore from this mine furnished by Edwin Mickley, Esq., of Hokendauqua, gives the following result:—

Silica,	40.770%.
Metallic iron,	38.238
Phosphorus,	.011

First Range.

The first range of ore in this district is represented by the *Gap Mine*,* Moll and Gery. This mine is on land known as the "Moll and Gery Tract," and is located at the end of the Catasauqua and Fogelsville RR., on the north flank of the hill. It was leased by the T. I. Co. in 1864, who put down a shaft 70′ deep on an 85° south-east dip, all the way on ore. Bed averaged 8′, but was greatly mixed with rock. Water was pumped by a pole pump and about 3000 tons of ore taken out and sent to the Hokendauqua furnaces. Mine was abandoned in 1869 and the lease returned to the owners.

In 1876 a lease was taken out by Messrs. Moll and Spinner, who took out about 40 tons of the outcropping and sent it to the Kutztown furnace. Financial disability led to an abandonment of lease which in 1878 passed into the hands of the Bethlehem Iron Co.

* References: Messrs. W. H. R. Smink, Edwin Mickley, and Wm. Donsen.

Shaft was sunk 30′ more, new pumping and hoisting machinery put in, and about 1100 tons taken out and sent to the Bethlehem furnaces.

Necessarily the cost of mining here was considerable, both on account of the great hardness of the rock, a tough close-grained syenite, and the intimate mixture of the ore with it, requiring careful sorting. Hence the mine was abandoned in 1881, and has been idle ever since.

The ore is magnetic, and while samples yield a high percentage of iron, the average is low.

The bed runs in benches similar to Fig. 11, page 191, the foot wall bulging in and cutting off the ore. There is one gangway west 20′ in rock at bottom of shaft.

Bethlehem Iron Co. analysis gives:

Fe. 47.755. $P = .015$. $SiO_2 = 28.48$.

McCreath's analysis of ore from Gery's Gap mine, 136 pieces dried at 212° F., which is a better average sample, shows:—

Metallic iron,	30.250
Sulphur,	.175
Phosphorus,	.020
Silicious matter,	51.190
Phosphorus in 100 parts iron,	.066

Second Range.

Going east another opening has been made close to road, marked on map as *Conrad's slope*. This was driven down 75′ on a small 4′ bed, until a hard mass of flint was struck and the mine abandoned.

About 800′ N. E. of this last there is an abandoned open cut on the Rittenhouse property, just opposite E. Conrad's house. It is on the same range, 150′ long and 100′ deep, and struck by a tunnel 125′ long driven in hillside.

The old "*Rock mine*" or Rittenhouse Cut is on this second range of ore. It has already been described on page 246.

Third Range.

The next mine further east, situated on third range of ore about 50′ south of second range, is the *Ginkinger Mine*,

which occurs at an elevation above ocean level of about 1000′, and shows an open cut and shaft.

The ore has been worked on the outcrop in a crescent-shaped opening, with the two ends of the crescent pointing east. The dip here is about S. 55° E. 66°. The mine shows the same characteristics as the Rock mine.

The cut is about 100′ long, 40′ wide in the center, and tapering to 8′–10′ at both ends.

It is 50′ deep and extends by shaft 100′ more. The ore is of about the same average quality as elsewhere in the district, being largely intermixed with rock.

The gangue rock here is a distinctly stratified gneiss, consisting of white quartz, feldspar, and mica; blue in color and very hard.

The feldspar shows a good deal of weathering, setting free the quartz.

An analysis by Detweiler gives:

Metallic iron,	45.963%
Phosphorus,	.010
Silica,	24.820

This range of ore has been opened north-east down to the C. & F. R. R. in several small open cuts and shafts, varying from 50 to 100 feet deep. They have been mostly worked by the Thomas Iron Co. All are idle now.

The open cut immediately adjoining the Ginkinger tract, opened by the T. I. Co. on the Wm. Trexler tract, shows the following analysis of ore furnished by Mr. Mickley:

Metallic iron,	52.143
Phosphorus,	.022
Silica,	24.32

Going west on this range from the Ginkinger mine there are two more openings.

The first is a slope about 235′ deep, which was abandoned in 1881. A great deal of ore is said to have been taken out of here. Dip is about S. 50 E. 70°. It is one of the oldest workings in the mountain, and is shown on the sketch map Fig. 12, page 245.

About 100 feet southwest of this there is a small shaft 75′ deep. The bed is here only 3′ thick, and was too small

to continue working profitably. At that depth the bed is said to have faulted and been offset to the north. It is now abandoned.

Fourth Range.

The fourth range of ore is about 200 feet south-east of range No. 3, but has a strike more to the east, which swings the openings *north* of the C. & F. R. R. further away from the third range than those higher in the hill *south* of the railroad.

Beginning on the south-west, there are two small shafts and an open cut, up in cove, all of which are abandoned, showing dips to the south-east of 65°. It is more than likely that the ore in the Tunnel mine already referred to belongs to this range.

If 900 feet be laid off on the map from the Tunnel mine opening, it would throw the ore to the south-east of this range probably 200′. But when it is remembered that the ore in this mine is struck at 100′ vertically below the horizon of these openings, and with a decreased dip, it is very possible that the Tunnel mine bed will have its outcrop in the line of this range.

There is another small shaft to the north-east on this range between the main track and siding of the C. & F. R. R., showing a dip of S. 40 E. 70°, abandoned. North of the main track and below the railroad, there are three more shafts, one of them sunk to a considerable depth.

The Bethlehem Iron Company were the last operators here, and though the mine was abandoned when visited in the summer of 1882, there was still standing a good engine house supplied with an able Barber & Son hoisting and pumping engine.

This mine is on the property of Calvin Weiler, and is known as the *Weiler mine.*

The Thomas Iron Co. worked it till the panic of '73. It was afterwards worked for 3 years by the B. I. Co. About 10 tons a day were taken out from a 125-foot shaft, with east and west gangways 30′ long. Mining was very expensive owing to the hardness of the syenitic gneiss rock—here

largely mixed with hornblende—and the great quantity of water. Very little ore was found in the dump to permit of any judgment as to the character of it, but the following analysis, by Dr. H. G. Detweiler, of B. I. Co., is presented to afford some idea of its quality:

Metallic iron,	52.697
Silica,	24.25
Phosphorus,	.018

It is in my opinion entirely too high in iron, but it is only fair to state that the company would vouch for none of the analyses given me of this and other ores they use as representing *average* samples.

They are mostly analyses of samples sent in by mine owners, and therefore rather dubious.

Though the prospects for a renewal of mining here are not very good, it must not be supposed that there is not any available ore to be mined. On the contrary, some of the mines already abandoned have not seen their day yet, but the great leanness of the ore of the whole mountain, and the large admixture of rock will always tend to restrict its production to those years of special activity in the iron trade.

None of the mines are deep enough to admit of judgment on the continuance of ore; but the vast amount of dead work necessary in clearing from 20 to 30% silica from a furnace will always re-act on these ores, and they can only be profitably used when the furnace charge is composed of ores high in lime or alumina gangue.

Passing east from the Rittenhouse Gap ore district the first openings met with are on the

Geo. Wetzel Property.

The workings here consist of an open cut about 30′ deep and several insignificant shafts.

They are all located on the west flank of a small hill about ½ mile west from Red Lion Station, C. & F. R. R.

In the open cut there are several exposures of feldspathic gneiss of rather a sandy character, dipping about S. 3° W. 63°.

There is no ore in sight, and the mines have been abandoned for some time.

The ore was shipped from a wharf on Mr. Wetzel's land, where it was sampled by Mr. McCreath, with the following results.

Sample 140 pieces, dried at 212° F.:

Metallic iron,	38.400
Sulphur,	.006
Phosphorus,	.037
Silica,	40.060
Phosphorus in 100 parts iron,	.096

This shows the very refractory character of the ore.

The ore is magnetic, with a bright metallic luster, and fine grained.

Miller's Farm Mines,

situated on east flank of hill near public road, about 200 yards west from Red Lion Station, C. & F. R. R., on farm of C. Miller.

These openings are comparatively new, having been worked only since 1879 under a lease of the Crane Iron Co. to the Bethlehem Iron Co.

During the busy summer and fall of 1879, 100 tons a day were mined; but this production had fallen off to 40–50 tons in 1882.

When visited, May, 1882, ore was being raised from 5 shafts in a property of only 2 acres, the great number of openings being due to the faulted and broken character of the bed and the pernicious contract system of mining practiced throughout the region.

The ore is a rather earthy magnetite occurring between layers of soft brown micaceous and feldspathic gneiss, similar to the foot wall in the Tunnel mine. Scales of black and grey mica occur in great profusion in the gangue.

The shafts average 70 feet in depth, each one worked by a different contractor, and all under the management of the representative of the B. I. Co., Mr. A. S. Miller.

Forty (40) men are employed at the various openings: 20 miners, 2 engineers, and 18 laborers.

Ore is raised by windlass and horse-power. The mines

are located low in the valley, which makes them a prey to all surface drainage, so that water is a common enemy in all the openings, hastening decomposition of foot and hanging walls, and requiring extensive timbering.

Two steam pumps—a No. 7 Cameron and a No. 4 Knowles—are in constant use, requiring 16 to 18 tons of coal per month, at $3.60 per ton.

Ore is shipped from Red Lion Station wharf, costing 25 cents per ton haulage.

Ore is magnetic, dipping steeply 60° to 70° to the south-east. No analysis of this ore was made, but it will probably show 40% iron and as much silica.

Dunkle Property Mines,

form a group of abandoned open cuts and small shafts, situated on north flank of hill about 500 yards east from Red Lion Station, C. & F. R. R.

Actively worked in 1879 by numerous contractors in the interest of the Bethlehem Iron Co.

Messrs. Schroeder, Weiss & Brensinger had numerous small shafts down from 30 to 50 feet deep.

No regular deposit was found here, and the general character of the surroundings are similar to those at the Miller farm, showing decomposed micaceous gneiss of a light grey color. No dip. Ore was magnetic and of poor quality.

Further down the C. & F. R. R., and close to the Lehigh county line, there are several mines, one of which was still working at the time of my visit, known as the

Gardner Station Mine.

It has been leased from Geo. Greis and Benj. Wendling, owners, since the fall of 1879, and worked by James Moser in the interests of the Bethlehem Iron Co. Employs 10 men (7 miners, 1 engineer, 2 laborers), and is furnished with a whip and windlass; a No. 7 Cameron pump, pumping every 10 minutes through a 3½ inch pipe; consumes 20 tons of coal a month @$3 25

This is the shaft located close to the railroad track.

An old shaft stood prior to 1879 about 200 feet west of the road bridge, and the second or new shaft was put down in July, 1881, closer to the track and more in the valley.

The yield when visited was from 10 to 12 tons per day.

Ore is magnetic and is probably on the same bed as the Jacobs, Marstellar, and other openings on the north flank of Lehigh mountain, further east in Lehigh county.

Ore dips into the hill at about S. 40° E. 45°, between walls of firm feldspathic gneiss, requiring but little timbering in lower workings. The mine is seriously troubled with water, and mining expensive.

The shaft is down 125′, with a gangway driven along ore face.

The old shaft (worked by same parties) is 50′ deep, with a gangway N. E. towards hill 60′ long.

Ore bed is pretty regular and varies from 4 to 8 feet thick. Stoping was about to commence here (May 23, '82.) Bethlehem Iron Co. take all the ore, which though high in silica is low in phosphorus, and can be used for Bessemer iron. The following is an analysis by Mr. A. S. McCreath, from a sampling by him at the company's wharf at Gardner's Station, of 120 pieces, dried at 212° F.

Metallic iron,	35.450
Sulphur,	.023
Phosphorus,	.025
Silica,	42.340
Phosphorus in 100 parts iron,	.070

Before proceeding to give an account of the remaining magnetic mines in Longswamp township I think it best to insert a description of the Marstellar mine in Lehigh county, from information obtained by a personal visit and from the superintendent, Mr. Isaac Hoffer, whose many courtesies I desire to acknowledge here.

It is a fair type of this whole series of mines along the north flank of the South Mountains, and from the fact of its being in good condition, as well as in all probability on the range of those recently mentioned across the line in Berks county, this mine was selected for special description.

It is situated about 1½ miles south of Alburtis. The land

is owned by Thomas Marstellar, and has been leased for 10 years from April 28, 1881, to the Archaen Mining Co., of Lebanon, Pa.

The Messrs. Atkins, of Pottsville, held a lease prior to this one, and are said to have taken out about 15,000 tons of ore.

The mine is worked by a slope on the ore, dipping about S. 40° E. 37°, carried down from the outcrop.

There are two parallel beds on the property, the slope being located on the most northern bed, which averages from 5 to 6 feet thick. From test holes on the property the two beds must be about 5 feet apart, the second or southern one being about 3 feet thick.

At bottom of slope a gangway was driven east 40 feet in ore, where the dip became almost vertical, though pitching slightly to the N. E.

The bed is faulted here and thrown about 10′ to the north, as the gangway after being driven about 10 feet in the hanging wall was turned sharply to the N. W. into ore again.

About ¾ mile to the N. E., the pitch of the bed carries it down beneath the primal slates and magnesian limestone of the East Penn valley.

To the west, the outcrop has been followed through several tracts of land nearly to Gardner station, and in a direct line with the B. I. Co. workings there. The ore is regularly bedded between walls of laminated Laurentian gneiss, and varies in thickness from 3′ to 12′. Several other mines are located on this bed, among which are the openings of Newmeyer and Desh, about the 650′ contour, and the Jacob's mine.

This latter was idle, owing to the B. I. Co. having a long lease on it, and not caring to work it until their shorter leases on other neighboring mines were exhausted. The Jacob's bed is said to be 20 feet thick in places, but this thickness can be only a very local one, if it exists at all.

The Marstellar mine employs 8 men, and the ore is all used by the Clymer Iron Co. and Kauffmans, of Leesport. There is a No. 4 Cameron pump at the mine, and a whip and

windlass. Consumes 4 tons of coal per month, at $3.60, and ships from Heinle's wharf on the C. & F. R. R., costing 25 cents per ton haulage.

The accompanying analyses are by Hollenbush, of Reading, No. 1 being average ore at surface, No. 2 ore for lower workings:

	No. 1.	*No. 2.*
Oxide of iron,	61.24	81.86
Oxide of manganese,	0.18	.12
Alumina,	2.75	3.17
Lime,	0.23	0.21
Magnesia,	0.84	0.48
Phosphoric acid,	0.10	0.11
Titanic acid,	——	trace.
Water by ignition,	1.81	1.25
Insoluble residue,	32.42	12.32
	99.57	99.52
Metallic iron,	42.86	57.30
Phosphorus,	.044	.048

Most of the ore has to be carefully picked and sorted before use, and No. 2 apparently represents such a sampling. The ore in the mine can't run over 45 per cent. metallic iron.

In all the mines from here west to Rittenhouse Gap the *increasing* dip in ascending the mountain will be noticed as well as the decided N. E. pitch of the outcrop.

The ores are all very refractory, owing to the great quantity of silica they contain, and can only be advantageously used when carefully and judiciously sorted.

The next range of ore-bearing rocks north is in the hills lying north of the Catasauqua and Fogelsville R. R., and between it and Lock Ridge, mostly owned by the Thomas Iron Co. and worked in their interest.

The ores in this range are peculiar, bearing a close resemblance to magnetic ore in color and luster, and yet giving a red streak like red hematite.

However, they are regularly interstratified with gneiss, and being semi-magnetic may be classed in this series. When visited during 1882 the whole hill was idle with the exception of the

Mickley (New) Mine,

located at the nose of the hill in Lehigh county, just across the Berks county line, and about 100 yards from the public road.

This mine is owned by the T. I. Co., who purchased it from the Messrs. Mickley, who originally opened it in conjunction with James Finley, of Maple Grove. The same parties have likewise opened several holes and small shafts on this hill, east and west, from 15 to 80 feet deep.

The Mickley mine is furnished with a small windlass and a shaft about 60′ deep at the time of visit, with a gangway N. E. towards nose of hill.

The ore runs from 6′ to 10′ thick, and is washed and prepared at the mine and separated from its gneiss rock gangue.

The following analysis of this ore was made by R. A. Patterson, Esq., chemist for the company at the Lock Ridge furnace, Alburtis, which though rather high for an average specimen of the ore mined, fairly represents its character:

Oxide of iron,	71.82
Alumina,	.17
Lime,	.60
Magnesia,	.53
Silica,	26.36
Phosphoric acid,	.07
Sulphur,	.49
	100.04
Metallic iron,	= 50.28
Phosphorus,	= .03

Were it not for the high percentage of silica this would be an excellent ore. Partial analysis of a soft variety from same mine by Mr. Patterson shows:

Metallic iron,	= 44.84
Silica,	= 34.32

The hill immediately west of this mine in Berks county is composed mostly of a quartzose feldspathic gneiss, easily weathered, and carries on its north flank a considerable number of flint boulders, probably belonging to Potsdam sandstone.

The property is mostly owned by T. I. Co., and though

the scene of much activity in 1879, is literally abandoned now.

It is riddled with mine holes of all descriptions, small shafts and open cuts too numerous and insignificant to enumerate.

It looks as if a traveling mining camp had located in this hill, moving camp every few weeks, and leaving as landmarks some shafts or open cuts to mark its progress.

Finley's Shaft, 60′ deep on the west slope of the hill, is one of the best. No very encouraging success was obtained here, however, the bed being rarely over 5′ thick, and very much broken up.

The old *Mickley mine*, higher up the hill to the S. E., yielded a considerable amount of ore before it was abandoned, and was sampled at the wharf at Gardner's Station by Mr. McCreath, who reports the following analysis—ore dried at 212° F., 131 pieces:

Metallic iron,	39.550
Sulphur,	.033
Phosphorus,	.028
Silicious matter,	41.110
Phosphorus in 100 parts iron,	.070

On the south side of the hill, 50 feet up from creek, there is another series of holes, many of which were worked in 1879 by Smoyer and the B. I. Co. On John Saul's property, the latter worked a bed from 5 to 10 feet thick; but it showed no regularity, and was so cut off and faulted, that it rendered mining expensive and unremunerative.

An old adit close to the creek at Gardner's Station is said to have opened up a very good bed of ore; but being low down in the meadows, and close to the creek, it was completely swamped with water.

Going west and up Swope Creek from Maple Grove towards the Gap there is a shaft located in gneiss rock, close to the creek, and about ¾ mile S. W. of Maple Grove. This must be the

Fegley mine or *Sol. Boyer & Co.'s mine*, from descriptions furnished by Mr. E. F. Cook, of the Warwick Iron Co., and Mr. McCreath, both of whom furnished analyses.

When I visited the mine in 1879 I met no one there who could speak English, and all the information I could obtain through my limited knowledge of Dutch was that Nathan Ziegenfuss was the contractor and the B. I. Co. the consumers.

The shaft was then 50 feet deep, employed 12 men, and turned out 12 tons a day.

The gangue was gneiss strongly impregnated with hornblende, and dipped conformably with ore S. 54 E. 60°. In 1882 it was idle; but during 1881 Mr. McCreath visited several mines in this region in company with Mr. E. J. S. Hoch, of Topton, and he has labeled this ore the "Sol. Boyer & Co. magnetite ¼ mile west from Nuddletown, 123 pieces."

Mr. Hoch writes me that "Nuddletown is a small village on the public road leading from Mertztown to Siesholtzville," which I judge must be what is called Maple Grove on the map.

Several other confusions of this character have arisen from similar causes, namely the sampling of ore from wharves or old banks, which were either abandoned when I visited them or else not located by the topographical party who had charge of the valley work.

In such cases I can only reproduce a copy of the analysis as furnished me by Mr. McCreath, and rely on the intelligence of those interested to locate the mines.

Mr. McCreath's analysis of the Sol. Boyer & Co. mine shows:

Metallic iron,	43.500
Sulphur,	.005
Phosphorus,	.057
Silica,	29.460
Phosphorus in 100 parts iron,	.131

Mr. E. F. Cook, of the Warwick Iron Co., Pottstown, gives the following analysis of the "Fegeley ore," sample sent by I. N. Keiper, Shamrock Station:

Metallic iron,	44.0
Silica,	37.5
Alumina,	4.0
Lime,	1.5

On the other side of this Laurentian gneiss anticlinal and on west flank of hill, there is a group of mines known as the

Frederick Mines,

located about 1 mile south of Shamrock Station, in Longswamp township, and about ¼ mile east of Trexler's Furnace.

They were, with one exception, all abandoned in 1882, though they were actively worked in 1879 in the interest of the Bethlehem Iron Company.

They are all located on the property of G. Frederick and were first worked by the Crane Iron Co. from 1875 to 1878, and afterwards by the B. I. Co.

Pursuant to the custom of this company these mines were all let by contract to individual operators through the company's agent, Mr. Stiles Levan, of Alburtis, and the work of destructive and unsystematic mining inaugurated.

In 1879 Messrs. P. and J. Razor, Thos. James, Geo. Fenstermacher, —— Reinhardt, and others worked 6 openings, varying from 15 to 120 feet deep, though only 3 of these shafts were of any importance.

The deepest (120′) shaft was equipped with a hoisting engine and Cameron and Knowles pumps; the others were worked by horse and windlass.

The output was about 15 tons a day, shipped from Shamrock Station, @ 30 to 40 cents per ton haulage.

The ore occurs in soft micaceous and quartzose gneiss, in no regular or continued beds, and always interbedded with the gneiss.

The region presents a similar aspect to the Miller mines at Red Lion Station, the ore dipping steeply to the southeast.

The causes of abandonment were natural;—too much water and too little ore.

The only opening worked in '82 was situated at the extreme north edge of the property, and was leased in March, '82, by I. Reinhardt.

The shaft was about 40 feet deep and rigged with a windlass. Yield was about 20 tons a week, costing, delivered

to Horatio Trexler at Shamrock wharf, 35 cents per ton haulage and sells at $1 25, subject to a royalty of 35 cents.

Bed is about 2½ feet thick here, and dips 70° to the south east into hill.

It is probably this ore that McCreath sampled at mine, and of which the following is an analysis from 165 pieces. dried at 212° F.

Metallic iron,	35.500
Sulphur,	003
Phosphorus,	.042
Silicious matter, (chiefly quartz,)	43.785
Phosphorus in 100 parts iron,	,118

The only remaining magnetic iron ore mines in Long swamp township are

Fritch & Bro.'s Bank,

which was not located on the map, and consequently, in my review of the territory contiguous to my own district it was not looked for.

It is located by Messrs. McCreath and Hoch as 2 miles south of Mertztown, which would bring it along the north flank of the Laurentian gneiss hill, here very hornblendic, and about 1 mile west of Trexler's furnace.

The sample, 141 pieces, was taken from the ore pile at Merztown, and McCreath writes that it was strongly impregnated with hornblende. The mine is abandoned now.

Metallic iron,	22.100
Metallic manganese,	.720
Alumina,	6.748
Lime,	22.400
Magnesia,	9.830
Sulphur,	.028
Phosphorus,	.018
Silica,	30.590
Phosphorus in 100 parts iron,	.081

Tatham Mine (Gregory Mine?).

Located 1 mile S. E. from Topton, and about 300 yards east of summit 790, and near public road.

The mine has been open about 15 years, and was worked by an open cut on outcrop until 1878—from which a good

idea of the generally hornblendic character of this range of the South Mountains can be obtained.

The cut is about 30 feet deep and 40 feet wide, and from its narrow opening at the north end, it extends about 70 feet to the south-east, ending in a perpendicular face of Laurentian syenite. From the bottom of this cut a shaft was sunk in 1878 on the ore, which, becoming too weak for mining purposes, was soon abandoned for a slope further west. This was commenced from surface of ground at top of cut, and extends on a 60° dip for about 80 feet—probably 50 feet of it being underground. The shaft was 46 feet deep. The slope is furnished with a double track for hoisting cars, which are run off on an east drift from slope bottom.

The ore is magnetic, but occurs in no regular bed, being disseminated through a rock stratum 20 to 25 feet thick, consisting of the lime, magnesia, and alumina silicates, and occurring between walls of dark green pyroxene and black hornblendic rock.

These all dip conformably 40° to the south-east, the strike of the ore rock being nearly east and west.

From foot of slope a gangway 25′ wide has been driven in this ore-bearing strata for 50′ (Oct. 1, '82), and in this distance the workings have been carried up 25′ above level of slope bottom in order to follow and keep in ore. At this rate they cannot be over 30′ vertically from the surface, and will come out some little distance east of shaft in the open cut.

For some inexplicable reason a tunnel was driven *east* into the perpendicular face of rock before mentioned. From its direction no success could have been expected, as it ran nearly parallel with and back of the ore bed.

The object was to test the presence of a second bed, supposed to exist south of the first, but obviously the wrong direction was chosen in driving the tunnel.

An adit was afterwards driven *south* from the underground workings, and is reported to have struck a 14-foot bed.

This is extremely doubtful, however, as the bed now

worked is called a 25-foot bed, whereas in reality the ore-bearing rock is scarcely that wide, and after mining must be carefully sorted before it is at all merchantable.

The following analysis by Mr. McCreath from 205 pieces, sampled from ore pile at Topton furnace, will show the character of the ore:

Metallic iron,	28.950
Metallic manganese,	.360
Alumina,	8.070
Lime,	13.770
Magnesia,	8.749
Sulphur,	.002
Phosphorus,	.006
Silica,	26.020
Phosphorus in 100 parts iron,	.020

Rockland Township Mines.

Rockland township joins Longswamp on the west, but though it contains the same range of rocks, no openings are worked at present in the township.

The *Absalom Beitler mine* is spoken of as occurring in this township, but while Mr. Beitler's house is undoubtedly in Rockland, I think the mine is just across the line, and in District.

However, Mr. McCreath gives an analysis of this ore in M^2, page 229, as occurring in Rockland, so I will describe it under this heading.

Beitler Mine.

This mine is situated about ½ mile south-west of Fredericksville and near the summit of the hill, 1160 feet above ocean level.

Mr. Absalom Beitler is the owner.

The mine has been worked for over 100 years, and its product was formerly taken down to Lewis Rohrbach's forge, from where a number of tons of old ore were recently hauled to Lyon's furnace.

When visited, June 6, 1882, it was being worked under a lease held by Thomas Weaver & Co., of Allentown, dated March, 1880.

The ore is magnetic, rather coarse grained and imper-

fectly crystallized, very hard and tough, with a black color and metallic luster.

Much of it is very clean, requiring little washing; but the mass shows a considerable amount of pyrite and greatly mixed with gangue rock, mostly feldspar and quartz, and must be carefully picked and sorted before it is shipped.

The average production in 1881 was about 10 tons a day, but the output is greatly curtailed by the system of mining pursued and the character of the deposit, which prevents more than 4 miners working at one time.

As the mine was pretty well filled with water at the time of visit, owing to the breakage of some machinery, no personal inspection could be made beyond a depth of 60 feet; and when again visited, in the fall of 1882, the mine had been entirely abandoned.

Mr. John Pascoe, the superintendent of the mine, furnished me with the following information. There are two slopes on the property, employing 18 men. A 25-horse power engine is used at the No. 1 old slope, using a ton of pea coal a day, costing $3.25. A No. 6 Knowles pump is employed to pump water, though its full capacity (30 gallons per minute) has been never required, as the mine has just about sufficient water to meet the requirements of washing, etc.

Down No. 1 slope about 60′ a hole was cut out for a cistern, which caught all the surface water dripping from above. This was pumped directly from here to the surface.

At a depth of 240 feet on the slope—the point reached June 6th—a stream of underground water was met, which completely drained the No. 2 slope, situated higher up the hill. It was this water that prevented an exploration of the lower levels at the time of my visit.

The ore is shipped from Bower's Station, on the E. P. R. R., 4 miles distant, costing on cars 65 cents per ton. The principal consumers at that time (June 6th) were the Saucon Iron Co., Leesport Iron Co., and the Sheridan and Kutztown Furnaces. No. 1 slope is down 240 feet, and followed ore all the way down from outcrop.

The bed at the surface seems to have been from 10 to 12

thick, with a foot wall of easily decomposed quartzose gneiss, and a hanging wall of harder hornblendic syenite.

Frequent attempts have been made to follow leaders of ore east and west, so as to get room for stoping; but in every case these leaders pinched out from 10 to 12 at the slope to a mere string in a distance of from 10 to 30 feet. Mining is consequently very much restricted, and the necessity of removing all the gangue with the ore renders it expensive as well.

A new shaft was at one time started about 60 feet S. W. of No. 1 slope, in rock, but it was abandoned when only down 40 feet. If it had been continued it would have probably struck the ore bed, which could then have been worked upwards and downwards at less than half the present cost, and with much greater facility.

For the first 60 feet the dip of ore and rock is a regular one S. 15° E. 67°, but at that depth the bed slumped up to half that amount, showing only about 30° down to the 240′ level, which is, *vertically measured*, only about 150 feet beneath surface.

No. 2 slope has been but recently started and is situated vertically about 30 feet higher than the old slope and about 300 feet S. E. of it.

The two beds are about 60 feet apart horizontally.

The No. 2 bed is about 3 feet thick, with all the characteristics of the old bed, though the ore is rather more mixed with gangue.

This slope is provided with a horse and windlass hoist. At a depth of 50 feet, dipping about the same as No. 1, the bed rises similarly to one half its dip. The ore brought $3 50 per ton.

The following is an analysis by McCreath, but it can not possibly be the average ore, unless he managed to get an extremely well-picked sample :

Metallic iron,	63.750
Metallic manganese,	.936
Sulphur,	.224
Phosphorus,	.040
Alumina,	3.750
Lime,	.090

Magnesia,	.400
Titanic acid,	3.930
Insoluble residue,	1.010

The titanic acid will be noticed in this as probably giving the ore its lustrous appearance.

The following are some additional analyses of this ore by the Pottstown Iron Co., who have used it:

	1.	*2.*	*3.*	*4.*
Oxide of iron,	93.8	——	77.6	57.1
Silica,	2.11	9.2	9.2	20.3
Lime,	.48	5.0	.8	1.1
Alumina,	3.13	31.2	11.3	19.3
Magnesia,	——	——	.2	.9
Sulphur and titanic acid,	1.20	——	——	——
Metallic iron,	67.42	53.0	56.17	41.3
Sulphur,	——	——	1.9	1.9

No. 1 is by W. D. Church, chemist for Pottstown Iron Co., sampled July 19, 1880. Iron estimated.

No. 2, M. P. Janney. No. 3, W. D. Church, September 29, 1880. No. 4, W. D. Church.

These analyses vary greatly, but such is the character of the ore that I believe them all possible. The ore when mined was sorted into three piles and so graded, each pile representing a very different percentage of iron.

The ore was sold on a certain basis of contained iron, so that this picking and sorting was a necessity in order to obtain sales at all.

Some magnificent specimens, weighing many pounds, of almost pure magnetic oxide have been raised, whilst again much of it is hopelessly mixed with gangue and impurities.

Ruscombmanor Township Magnetic Ores.

Fully one half of this township is composed of the Potsdam (Primal) sandstone, carrying hematite and limonite; but the other half, composed of Laurentian gneiss, has been somewhat explored for the magnetic ores, and among the chief developments are the:—

Clymer Mine.

An open cut, situated about 1¼ miles S. S. E. of Price-

town, on the south flank of Furnace Hill, and close to the Friedensburg-Blandon road. When first seen, during the summer of 1880, this cut was being actively worked under the superintendence of Benj. Wyle.

The cut was about 250 feet long and 40 feet wide, and about 40 feet deep.

The ore was taken out of the cut directly with carts and hauled to the Clymer Co.'s furnaces, Mt. Laurel and Temple, in the East Penn valley, and a small portion of it to the Oley furnace (charcoal) at the eastern end of Furnace hill.

The ore is mostly a soft and fine dull black earthy powder, showing numerous scales of black and brown mica, and for the most part a magnetic oxide.

The bed was from 1 to 4 feet thick, often dividing and forking into several branches. It was being then worked at the eastern face, and was cut down from the outcropping to the bottom of the cut.

Bottom rock was a syenitic gneiss, dipping with the ore S. 30 E. 60°; top rock was a decomposed greenish black slate, (lower Primal?) which in reality was largely mixed with the ore.

Singularly, the ore near the top rock was harder and more highly crystallized than that nearer the bottom rock, and frequently showed balls of porous hard ore, with distinct octohedral crystallization.

Potsdam sandstone occupies the crest of the ridge,* lying *unconformably* on the gneiss, and dipping N. 20° E. 35, often showing beds of a purple conglomeritic quartzite, with large quartz crystals.

On July 19, 1882, when again visited, the mine was abandoned, on the plea that no regular or persistent bed could be found there.

Meanwhile the workings had been extended along hill towards old Tunnel mine, and several holes dug to test the

* This hill is given in Chapter II as an anticlinal. It is either an overturned anticlinal of gneiss, with Potsdam lying against its north leg, or a monoclinal with Potsdam lying on the upturned edges of gneiss. In either case the P. S. S. is unconformable.

continuance of the bed. One of these latter was supplied with a windlass, and was probably 40 feet deep.

Considerable soft ore was found near this shaft on dump, which was filled with mica scales. Not far to the east there was a pile of greenish black slates, the same under which the ore occurred in the open cut.

The ore where found is of excellent quality and in its finely divided state and mixture with easily fluxed materials, it was readily used in the furnaces. Its high percentage of manganese makes it valuable for Bessemer iron.

The following is an analysis of a sample from about 15 pounds of ore sent Mr. McCreath:

Metallic iron,	59.100
Metallic manganese,	7.507
Sulphur,	None
Phosphorus,	.068
Silicious matter,	0.860
Phosphorus in 100 parts iron,	.115

This is apparently an advantageous sample for all told the ore will run about 45 % Fe.

Its freedom from sulphur and phosphorus and silicious matter should encourage further exploration.

The mica-like plates found here are probably a variety of Muscovite.

Tunnel Mine.

This old mine, whose operations date back to the last century, is now entirely abandoned and fallen in so that no examination could be made of it.

It is on the property of Wm. Clymer & Co., about 2 miles N. W. Friedensburg, and is situated close to the Ruscombmanor-Oley township line, though probably in the former.

It is on the direct line of strike of the Clymer open cut and about 200 feet east of it, and on south flank of Furnace hill.

Very little could be learned about it, but it is said to have yielded both hard and soft ore of excellent quality. Thinning of the bed and an excess of water led to its abandonment, the tunnel driven in to tap the latter having entirely failed of its purpose by reason of its being badly located.

It should have been started *below* the public road instead of *above.*

Several attempts have been made, I believe, by the Clymer Iron Co. to clean out the workings in the hopes of finding a large body of good ore that was left as a roof support in the mine, but nothing of any account seems to have been accomplished.

There is reason to believe that this is the mine referred to by Rogers in Vol. II, p. 716, of his Final Report, of which he says:

"At this spot (2 miles N. W. of Friedensburg) is the old iron mine belonging to the Oley furnace. The ore was dug from immediately under an outcrop of Primal sandstone, the digging running parallel with it for more than 100 yards, and being 18 or 20 feet deep and 8 or 10 feet wide. This mine, now abandoned, furnished us some specimens from the side-wall of the excavation. These are argillaceous and laminated, and of a purplish-red color. A shaft unites the main excavation with another nearly under the first, having about the same direction, but descending more perpendicularly. The latter mine is from 3 to 5 feet wide; the wall is of metamorphic rock, chiefly feldspathic and hornblendic gneiss, but sometimes entirely micaceous, and it contains in certain places magnetic and micaceous iron ore. The rocks passed through in a tunnel are gneiss, syenite, hornblende, and micaceous slates."

Mr. McCreath sends me an analysis of the "Geo. W. Kerchner bank, 4 miles south-east from Fleetwood. Sample 108 pieces from ore pile at mine. Red hematite, slightly magnetic," which I present below. Such a location must place it in Oley township, though I know of no mine answering that description:

Metallic iron,	35.000
Sulphur,	.007
Phosphorus,	.193
Silicious matter,	40.000
Phosphorus in 100 parts iron,	.551

Of other exposures in Ruscombmanor township Rogers states on same page that:

"Near Pricetown, on Rauzbaum's farm, an old pit or

shallow shaft has been re-opened. The ore is highly magnetic and of excellent quality, but the vein is not a promising one, being only a few inches thick."

"At Road's, near 2 miles E. of Pricetown, there is a magnetite of superior quality, said to be between 5 and 6 feet thick. Its dip is perpendicular."

Such is Rogers' record of Ruscombmanor township.

Possibly "Road's vein" is the ore bed occurring about 1¼ miles east of Pricetown, known as

Schittler's Ore Bank,

located on land originally owned by Milton Schittler.

Passing through the hands of Mr. Haines, it is now owned by Eckert & Bro., of Reading, who were unable to furnish me with any information when written to.

It shows an old abandoned shaft, located close to the creek which marks the divide between Potsdam No. 1 and the Laurentian gneiss, here very hornblendic. Considerable magnetic ore was found in the field near by and several chunks picked up from old dump.

These pieces exhibit a highly crystallized, tough, black magnetite, often showing bright metallic faces.

The percentage of iron will be high, but is probably titaniferous. Imbedded in it are beautiful chocolate brown, lustrous and opaque crystals of Zircon, sometimes an inch in length, but rarely perfectly terminated. They have been analysed by Dr. Chas. M. Wetherill (Trans. Am. Phil. Soc. X, 340), who reports:

Spec. gr.,	4.595
Silicic acid,	34.07
Zirconia,	63.50
Ferric oxide,	2.02
Water,	0.50
	100.09

Zircons have also been found in magnetite on the farms of W. Haines, Schroeder, and Mrs. Rhoads, and also near Barnhart's dam in Muhlenberg township.

Oley Township Magnetic Ore Mines.

The limited area of Laurentian rocks in Oley township, confined to the north and north-west corners of it, removes it from the field of magnetic ore producers; but what there is of those rocks certainly belongs to this north range of gneiss, and justly claims attention here.

Immediately south of Furnace hill—or, more exactly, its eastern extension, known as Sheep hill—there is a gneiss hill, which branches off from the main hill at the Oley furnace, and extends along north of the Lobachsville road into Rockland township.

It is this hill that seems to carry the bed of ore already referred to in the accounts of the Clymer open cut and Tunnel mine, and on it in Oley township there are three openings, all showing the same general characteristics in their ore bodies, and all resembling the Clymer open cut ore in its physical properties. It is rather more brown in color than the black powder of the Clymer mine, not so rich in iron, and shows a higher percentage of silicious matter.

No work was being done at these openings—which are all shafts—at the time of visiting them; but considerable ore piles still remained at the shafts, from which samples were taken.

The two most western shafts were opened in 1874, and leased in 1879 by Dr. Hertzel and Frank Swoyer. In that year the east shaft was down 24 feet, and from the bottom a gangway 33 feet along strike of bed. The dip was about 40° to the southeast. The ore was then taken to Fleetwood.

The foot wall was a black hornblendic syenite, which was exposed a little further east on the crest of the hill, dipping S. 20 E. 48°.

The ore is filled with brownish mica scales, and shows the following constituents from an analysis by McCreath of a sample sent him from 20 lbs. of the ore:

Metallic iron,	25.150
Metallic manganese,	3.689
Sulphur,	—
Phosphorus,	.
Silicious matter,	25.440

The other opening is on property of Benj. Yoder, and is

located on hill about 100 feet up from road, and close to the Rockland township line. This mine was started in 1879, and was carried down 100 feet with the same characteristics as the "Hertzel & Swoyer mine."

The mine is known as the "*Talley mine.*" The dump shows a good deal of fine black and brown ore, and near by a considerable amount of black hornblendic rock.

The following analysis by McCreath is from a sample collected by him from 20 pounds of the ore, taken from pile at the mine, and shows a similar character to that just described.

Talley Mine.

Protoxide of iron,	5.335
Sesquioxide of iron,	36.357
Sesquioxide of manganese,	2.586
Sesquioxide of cobalt,	.110
Oxide of zinc,	None.
Oxide of copper,	Trace.
Alumina,	6.305
Lime,	4.260
Magnesia,	16.601
Sulphuric acid,	.035
Phosphoric acid,	.100
Water,	7.806
Silica,	20.750
	100.245
Metallic iron,	29.600
Metallic manganese,	1.801
Sulphur,	.014
Phosphorus,	.044
Phosphorus in 100 parts iron,	.148

Alsace Township Magnetic Ore Mines.

Alsace township seems to have been sparingly worked for magnetic ore mines, though its Laurentian rocks bear many evidences of its presence.

Rogers mentions one locality (page 716, Vol. II,) as "2½ miles south of the canal," but as there are no evidences of a canal in this township it is rather difficult to know exactly where this opening was. Of it he says:

"This vein occurs in gneiss rock and is double, being divided by a wedge of granite or granitoid gneiss. The strata

dips S. 80° and the vein has the same inclination. The whole thickness of the vein is about 8 feet, but the good ore only measures 4 feet, and this is in two veins of 2 feet each, the rest of the ore being inferior."

Evidences of old workings exist about 1 mile east of Koch's tavern, on the Reading-Pricetown road, where, about 500 yards south of road and about half way up the Laurentian gneiss hill north-east of J. C. Gauby's house, there is an old shaft about 40 feet deep. There is on dump some few pieces of good magnetic ore, tough, sub-crystalline, and with a metallic luster.

The "country rock" is an intimate mixture of feldspar, hornblende, and quartz, with a little mica, the former probably predominating.

About ½ mile north-east of the Stony Creek mills, and just north of the Reading-Friedensburg road, on property of Mr. David Knabb, there is an old abandoned opening, which is said to have furnished a good many tons of good magnetic ore.

The whole ridge of this crest from the road up to the summit has been opened in various places, evidently with an idea of proving the territory.

They all show gneiss, dipping about S. 60° E. 35°, carrying iron ore, though greatly mixed with quartz.

The gneiss is distinctly stratified in thin seams often ferruginous. Some loose pieces of ore were picked up at the largest opening, which exhibit a fair quality of ore, but were not plentiful.

There is one more shaft which seems to have proved unsuccessful, located about 100′ up from road just west of D. Fisher's house, on the Reading-Ohlinger dam road.

The country rock here is black hornblendic syenite, and no ore is visible in the pile of refuse stuff at the mine dump.

The numerous streams that pour down the side of this hill into the waters of the Antietam creek all expose small chunks of magnetic ore in their beds mixed with wash-earth, and this fact probably led to the trial shaft just spoken of.

The great quantity of black hornblende occurring in

crystals of all sizes through this range is very deceptive, and when met with in other parts of the mountains is spoken of as "Black Jack" by the miners. Much money has been spent in various parts of the county under the belief that it was iron ore.

Reading.

Within the city limits of Reading there are various old openings exposed on the south flank of Mount Penn, between the fair ground and the Mineral Spring hotel, and from all accounts the locality must have been an active one some years ago.

Everything is abandoned and shut up now, but Rogers, on page 116, vol. II, gives a description of what existed during the time of the first survey.

The Potsdam sandstone, which everywhere covers the crest and west flank of Mount Penn from the Pricetown road to Reading, dies away at this place, and has left exposed on its south flank the underlying Azoic rocks.

Rogers places the ore here in immediate contact with the Potsdam sandstone, with which it is conformable, though from the position of the two rocks, I am inclined to think it referable to the gneiss,* though close to the Potsdam.

His ideas of igneous iron ore injected into its present position I can hardly accept, for reasons given in the beginning of the chapter, but as I had no opportunity of personally inspecting this deposit I can only reproduce his views and let those who are interested deduct their own theories. He says:

"The vein is apparently injected conformably to the bedding of the Primal white sandstone, and the ore is not accompanied by any bounding wall of igneous rock, but is in immediate contact with the rock itself.

"The latter rock disintegrates quickly on exposure to the atmosphere, and develops innumerable small grains of hornblende, which speckle the yellowish-grey sand. The ore vein ranges from the Reading fair ground a little S. of

* The nature of its gangue would seem to confirm this impression. See analysis.

E., dipping 45° S. Its thickness is seldom less than 18 inches, and has been as great as 28 feet. Under this enlargement it does not seem to suffer in quality. The ore itself is of a granitoid variety, highly crystalline, containing quartz and feldspar, especially the latter, in great abundance; hornblende and apatite enter also into its composition.

"The vein has been wrought at its surface, outcropping in the Reading fair ground and for $\frac{1}{3}$ of a mile east by Eckert & Bro.; the Phœnix Iron Co., and others. The principle mine is the vertical shaft of Eckert & Bro. This is sunk 142 feet to the level of a tunnel, which is cut N. 28 feet through rotten sandstone to the top of the vein.

"From this tunnel the vein is followed by a gangway 30 feet E. and 115 feet W. The ore is worked along the foot wall rising towards the surface, the hanging wall or roof being supported by timbers. The length of the breast to the old surface workings is 72 feet. The ore from this old level was obtained to a depth of 82 feet. * * *

"In Eckert's old level, 100 feet west of the whim-shaft, the vein split, but the north branch vein thinned away in 100 feet."

The following is an analysis of this ore given on page 717 of same report, which is described as "Crystalline magnetic ore, with hornblende, feldspar, quartz, and apatite."

Peroxide of iron,	36.50
Protoxide of iron,	16.25
Silica,	24.17
Alumina,	6.20
Magnesia,	7.10
Lime,	5.67
Potash,	3.30
Phosphorus and fluor. acids,	0.31
Metallic iron,	37.00

Going east once more to the Lehigh county line and taking up the middle and southern townships we have first to notice the

Hereford Township Magnetic Ore Mines.

Undoubtedly the most important mines in this township are those in the *Siesholtzville District*, situated about 1 mile east of the village of that name and in the northern part of Hereford township.

The openings are all located in the valley of the Perkiomen creek, which has its headwaters in the meadows just east of the village.

The boulders throughout this valley down to the Lehigh county line are all of Potsdam quartzite, and though there are no *surface* indications of the presence of limestone, yet its prominent outcrops in the Hampton Furnace quarries at the Lehigh line, and its frequent occurrence as gangue in the mines, (the "hard ore" being simply a mixture of magnetic oxide and limestone,) renders its position in this valley far from problematical.

The valley is flanked on the north by Laurentian gneiss, here consisting of feldspar, quartz, pyroxene, (variety *Sahlite*,) and hornblende, dipping to the south-east and forming the foot wall of the ore in the various open cuts and shafts of this region. The occurrence of this greenish mineral Sahlite is so prominent along this central range of the South Mountains, here and into Lehigh county in Furnace Hill, that it may be worth while to reproduce an analysis of it from Dr. Genth's Report B, page 66, determined by Mr. S. Castle:

Silicic acid,	49.30
Alumina,	14.98
Ferric oxide,	.053
Ferrous oxide,	6.02
Manganous oxide,	Trace.
Magnesia,	8.27
Lime,	21.45
	100.00

The south side of the valley is confined by gneiss rocks of a more quartzose and feldspathic character, which can be classed as granulite.

The magnetic ore mines lie well up on north side of valley, as will be seen by a reference to the map in Atlas.

When this district was visited May 20, 1882, it presented a strange contrast in its utter idleness to the busy scene during the summer of 1879, when the topographical map was being constructed. Much of the old machinery has been removed from the ground, and though it would be an exaggeration to say that the region has been worked out, yet excessive royalties demanded by property owners, combined with the fact that the soft and better quality ore is pretty well exhausted, and the "hard ore" is too lean to pay for working, will furnish sufficient reason for the abandonment of mining during the present condition of the iron market.

Though I have never been able to make an examination of the underground workings of the mines, owing to their continued idleness, I am informed on the best authority that a great quantity of this hard ore still remains; but as it rarely averages over 22 per cent. of iron, and is subject to a royalty of from 30 to 50 cents per ton, it is hardly fit to raise.

The map of this district, made by the P. & R. C. and I. Co., and published through their kind permission, shows the character of the openings on the Samuel Bittenbender and John B. Gehman tracts.

The outcropping is the "soft ore," resembling a fine grained black to brown powder, similar in character to that found in the mines along the south flank of Furnace hill, in Ruscombmanor and Oley townships. It carries about 45 per cent. Iron.

I am indebted to Mr. W. H. R. Smink, who has long been identified with the various mines of this district, for much of the information that follows, and desire to express here my thanks for his personal and professional assistance.

The bed of ore that has been worked on the tracts of Samuel Bittenbender and John B. Gehman's heirs, at Siesholtzville, is supposed to have been tested *east* on the lands of Levi Kreider in Berks county; on the tracts of C. Miller and Jarrett in Lehigh county; and even as far as Geo. Greis' Shimersville mine,* 5 miles N. E. Siesholtzville; but

* An account of this mine, in Lehigh county, will be found on page 293.

at the latter place the character of the ore is so changed (being a red hematite) and the gangue rock so different, that its identification there is problematical.

Going *west* from Siesholtzville it has been opened slightly on the lands of Geo. Moll and A. Benfield, and on the Rohrbach tract, where it was considered worthless on account of lightness and fineness, blowing out of furnace when used.

The bed has a tendency to bear N. E. and S. W., but has almost a due south dip of 40° to 45°. Prospecting shafts along line of outcrop have been sunk as deep as 53 feet; but the body of the ore seems as yet to be confined to the Siesholtzville tract.

Messrs. Smink and Morganroth report ore on the Kreider tract at the depth of 53 feet, 18 inches clean occurring in a bed proper of 8 feet, mixed with clay and calcareous matter, and about 18 inches on the Miller and Jarrett tract in Lehigh county.

Prospecting west on the above mentioned tracts was undertaken by the same parties, to a depth of 15 feet, but the bed seemed considerably broken up.

Mr. Jacob Gilberg continued these operations on the Benfield tract and reports about 2 feet of hard ore.

John Rush, of Dale Forge, is generally credited with the discovery of ore at Siesholtzville, and in 1838, from land then owned by D. Bittenbender, he took some outcropping ore back to his smith shop and successfully tested it for iron.

This is the property now owned by S. Bittenbender, and upon which the P. & R. C. & I. Co., and the Warwick Iron Co., of Pottstown, hold a joint lease.

About 1845, a few wagon loads of wash ore were taken down the valley to the old Hampton or Sigman furnace, close to the Lehigh line, where the ore was tried and successfully smelted.

Prospecting on a larger scale was afterwards begun in 1850 by the Messrs. Trexler, of Reading, but on account of the outcrop ore having been floated over a considerable area south of the bed they were unable to locate it properly.

In 1866 the Crane Iron Co. got a lease on the same tract, including the limonite bed 800 feet to the south in the valley, near the head waters of the Perkiomen creek.

They seemed to be ignorant of the good quality of the soft ore, and condemning this, they sought assiduously for the hard ore, which they thought would prove the true and better bed.

The whole property was abandoned by them except the brown hematite opening, to be explained further on in its proper chapter.

The lease then passed into the hands of Mr. Frank Thomson, who, though he found ore in abundance, was unable to hold the lease.

In 1872 Mr. Jacob Gilberg leased both the Bittenbender and Gehman tracts, and he may be said to have given the first impetus to mining in this district. He profited by the undertaking, too, for he soon very advantageously disposed of the lease of the Bittenbender tract to Messrs. Jones and Fegely, of the Warwick Iron Co.

Their shaft, 40 feet deep at the extreme western end of the property, is shown on the mine map of this district.

They associated the P. & R. C. & I. Co. with them, and operations on a large scale were at once commenced.

The ore was taken out by carts from open cuts and hauled to Red Lion station 1½ miles, on the Catasauqua and Fogelsville R. R.

It was first used at Pottstown, and subsequently by J. & J. Wister, of Harrisburg.

The P. & R. Co. soon got a controlling interest and proceeded to sink a slope further east, shown in the first open cut.

This was carried down 100 feet, and from it a large quantity of the soft ore was raised.

The next move was to sink No. 1 shaft (see map longitudinal section) at the eastern extremity of the property, which was carried down a little over 100 feet. From this shaft the character of the bed was found to vary greatly, swelling out into great pockets and then thinning to a bed only 3 feet thick.

These peculiarities are reflected at the surface, where any marked depression in the ground is found to denote a deposit of the soft ore, whilst the mounds and rolls indicate the position of the underlying hard ore.

The latter contains the most lime and magnesia, which making a ready flux, puts a value on this ore for mixing with the mountain ores high in silica which it would otherwise never possess.

The hard ore is found along the botton of the mine in continuous cone-shaped wedges, joined laterally together, with their apices pointing upwards, and in the pockets between them the soft ore is found, accounting for the great thickness of this latter variety in places, as well as for the unevenness of its foot wall.

Much timbering was required in this soft ore, which added considerably to the danger and exposure of mining.

The hanging wall is regular, any change in the thickness of the bed being due to the bulging of the hard ore and of the gneiss foot wall.

Just over the hard ore, and between it and the soft ore, there seems to be a layer of ore from 3″ to 1′ thick, forming a distinct bed of itself, with a shelly open structure.

This ore might certainly be termed "hard," but is very different from the calcareous ore forming the lowest ore body in these mines.

In this latter large boulders of clay and limestone are found, in the shape of balls from a few inches to 10′–12′ in diameter.

The former has an open cellular structure, almost free from gangue, and carries a high percentage of iron.

There is a distinct parting between the hard and soft ores in these mines, and no gradation of one into the other, and it is only a question of a short time how soon this soft ore will be removed, if not already pretty well worked out.

An inspection of the map accompanying this report will give a clear idea of the manner of occurrence of this ore.

All the gangways colored *brown* have been run in this soft ore. The size of some of the ore pockets may be judged by the excavations at the points F and G, (see the Longi-

tudinal Section,) which furnished in round numbers 150 tons.

This section shows 6 shafts to have been sunk on the Bittenbender tract alone, from which a double set of east and west gangways have been driven about 50 feet apart.

The system of mining this soft ore, owing to its yielding top and bottom, required a great deal of expensive timbering.

A shaft was first put down from the surface to the hard or bottom ore, and sometimes through the latter to the foot wall,—gneiss rock.

This shaft was double, with one side for hoisting and the other for pumps, as considerable annoyance was caused by the surface drainage from the marshy and soggy ground.

From the bottom of the shaft main gangways were driven east and west, and pillars of ore left standing to support the shaft.

At regular intervals along main gangways, "rises" or shutes were carried up to the surface, sometimes along hanging wall and sometimes along foot.

These "*rises*" were simply used to convey the ore mined down to the main gangway, where it was loaded on drift cars and taken to the bottom of the shaft and thence by the cage to the surface.

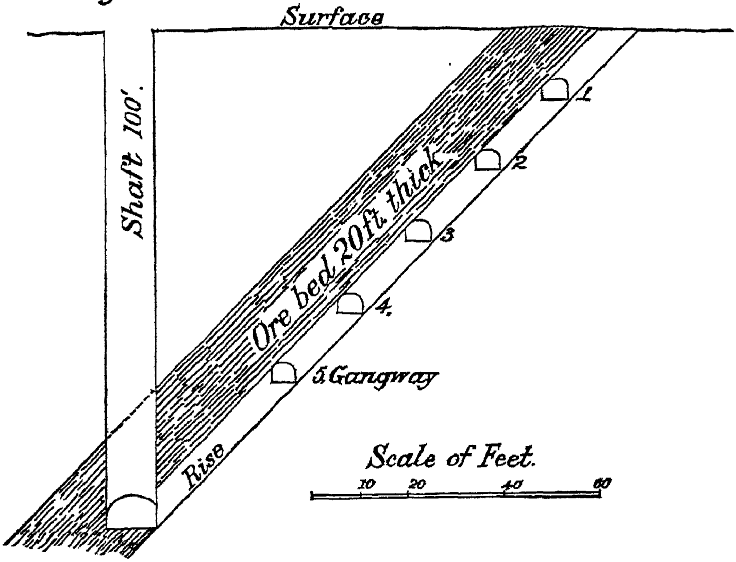
After these "rises" reached the surface counter gangways were driven, beginning at the *top*, towards each other from each "rise" until they met, and the top allowed to fall in.

In case the bed was very wide a second set of gangways were driven beside the first until the whole top of the bed had fallen.

This plan was pursued down to the bottom of the mine, a new set of counter gangways being driven where the first had filled up, so that the bottom of the first set was the top of the second and so on, the soft ore being always thrown down the shutes to the main gangway.

A sketch will probably render this explanation more clear. See Fig. 15.

Fig 15. Vertical Section showing manner of mining Soft Ore at the Siesholtzville mines.



All mining of soft ore had to be done with timbers ; the hard ore required blasting.

The hard ore was mined just the reverse to the soft, similarly to coal in breasts.

Much larger openings could be made without fear of the top coming in.

A cribbing was first started and all refuse matter used to fill up around it as it was mined.

This was carried on up to surface, keeping bottom filled as the work progressed.

Pillars of ore were of course left to protect the workings, some of which were afterwards removed while others are still standing.

The main shaft on the Bittenbender tract is furnished with a No. 10 Cameron pump, which, with the addition of a tank attached to the engine, pumped about 200 gallons of water per minute.

Work was carried on without interruption here from 1872

to 1877, and from 1877 to 1879 it was idle, though the water was kept out of the workings.

It was again in operation from 1879 to the spring of 1880, since which time not a ton of ore has been raised, and the mine has been allowed to fill up with water.

During the period of active working 118,000 tons of ore were mined, upon which Mr. Bittenbender was paid a royalty of 50 cents per ton.

This high royalty, together with the poor quality of the remaining hard ore, and the fact that further mining will necessitate the sinking of the shaft to procure ore, have all combined to entail idleness here. Nothing but a few pillars of ore, left to support the shaft and workings, remain above the present 100 foot level.

The following are some analyses of the ore in the Bittenbender tract, which being idle at the time of visit, could not be sampled for an analysis by McCreath, and were kindly furnished by the Warwick Iron Co.:

	1.	2.	3.
Metallic iron,	45.5	37.8	30.0
Manganese,	2.16	——	1.8
Alumina,	8.0	6.0	6.0
Lime,	3.1	19.68	14.6
Magnesia,	3.6	6.49	6.8
Silica,	16.5	9.5	11.0
Phosphorus,			0.08

No. 1. Fine ore Reading shaft, Bittenbender tract. Analysed by E. F. Cook, Warwick Iron Co. Atmospheric temperature.

No. 2. Ditto; lump ore.

No. 3 is from "Siesholtzville district," bank uncertain, and is from sample used in mixture for the short blast at the Warwick Furnace, described in Vol. IX, Trans. Am. Inst. M. E., by John Birkinbine. It is more than probable that it is the lump ore from the Bittenbender tract.

Gehman Tract.

Meantime Mr. Gilberg, who still retained the lease on the Gehman tract, began to open the bed on land of John B. Gehman, divided from the Bittenbender tract by a nar-

row wedge-shaped piece of land belonging to the *heirs* of J. B. Gehman. Though this is a virtual extension east of the Bittenbender ore, it was found to be not so clean and compact, so that Gilberg began by washing the surface ore.

After putting down several shafts the washing was dispensed with, owing to better ore having been struck, and from the fact that in the washing process much that was good ore was carried away with the wash water, owing to the ore being so finely divided.

The ore found ready purchasers when once introduced, and though large prices were offered for the lease, it was not sold till 1877.

Mr. Henry Guiterman, of Port Carbon, Schuylkill county, since deceased, was induced to take hold of part of the tract, a portion of the east end of the property being reserved by Mr. Gilberg.

By this time the ore had been taken out of the west end of the tract to a depth of nearly 100 feet, or about to the limit of the soft ore in the Bittenbender shafts.

A new shaft was put down in the spring of '77 by Mr. Guiterman to a depth of 180 feet.

Two hundred (200) feet was the projected depth when started, but as hard syenitic gneiss, the real foot wall, was struck at 180 feet, further sinking was abandoned.

A gangway was driven south off the bed, here found to show 7 feet thickness of good soft ore.

Drifts were then driven east and west on bed for 300 feet on each side of shaft.

Hard ore similar to that in the Bittenbender property was struck in these gangways, rather leaner in iron than that in the western property but showing a little larger percentage of iron in its soft ore than the Bittenbender mines.

Whilst Mr. Gilberg was operating he employed from 20 to 40 men. A great deal of ore was taken out by horse power before steam was introduced for raising purposes.

Since Mr. Guiterman's death the tract has been worked by his administrators, Messrs. L. B. Morganroth and I. N. Heilner, of Shamokin.

From 50 to 70 men have been employed here at one time and the daily production has varied from 30 to 100 tons.

Water was a considerable annoyance, 500 gallons per minute having to be pumped in order to keep the workings dry. This was next to impossible with the appliances at the mines,--one No. 10 Cameron pump. Work was stopped in 1882. 100,000 tons of ore are said to have been removed from this tract, upon which a royalty of 35 cents per ton gross weight was received.

Preparatory to any further developments here the shaft must be driven deeper, for, like the Bittenbender tract, the present workings are pretty well cleaned out.

On the tract reserved at the sale by Mr. Gilberg, at the eastern end of the property, about 12,000 tons have been mined.

Messrs. Chalins & Co. took this reserved lease off Mr. Gilberg's hands and put down a 100-foot shaft.

After working for a short time they disposed of their rights to Schweinbinz & Co., who in turn soon transferred them to the Bethlehem Iron Co. The latter party carried the shaft down to 130 feet. No hard ore has been found on this part of the property, but the workings have been abandoned owing to the ore having become very dirty and the bed very irregular.

The royalty here was originally fixed at 65 cents per ton, but was eventually reduced to 35 cents.

The yield from this entire district, about 3,000 feet in length and averaging 130 feet in depth, has been about 230,000 tons, and the value of the entire tract can be judged from the following figures.

Mr. Smink estimates the average cost of mining per ton of 2,000 lbs., at $2.00; average price per ton received at $2.40. from which the following table has been compiled :

Table No. 1.

	Number of tons 2,000 lbs. mined.	Average cost per ton of 2,000 lbs. at \$2.00.	Average price received per ton of 2,000 lbs. at \$2.40.	Profit to mine operators.	Profit to property owners, calculated from royalties received from different tracts.	
Bittenbender tract, .	118,000	\$236,000	\$283,000	\$47,000	@ 50 cents,	\$59,000
Gehman west tract, . . .	100,000	200,000	240,000	40,000	@ 35 cents,	35,000
Gehman east tract, . . .	12,000	24,000	28,800	4,800	@ 50 cents,	6,000
Totals, . . .	230,000	\$460,000	\$551,800	\$91,800		\$100,000

The low price received (\$2.40) for this ore seems surprising; but when it is taken into consideration that the value of this ore, owing to its bad repute in early days of mining, was little understood, the above figures will assume more reliability. The Philadelphia & Reading Coal and Iron Company, through Messrs. S. B. Whiting and S. C. Harris, have kindly furnished the following figures for comparison, estimated through a period of 8 months—January to August, 1880—which comprises the period of last mining done by this company on the Bittenbender tract.

Table No. 2.

1880.	Tons mined.		Expenses.		Cost per ton.		Price received per ton.	
January, ...	580	10	\$548	22	\$	94^{3}	\$2	80
February, ...	614	06	413	21		67^{1}	2	95
March, ...	513	14	437	84		85^{2}	2	70
April, ...	593	07	384	63		64^{9}	3	22
May, ...	692	09	909	66	1	31^{4}	3	18
June, ...	621	03	619	52		99^{8}	2	38
July, ...	152	00	439	92	2	89^{5}	2	43
August, ...	125	07	506	83	4	05^{5}	2	81
Totals, ...	3,892	16	\$4,259	83	\$1	09^{4}	\$2	81

In this table, royalty and cost of hauling to railroad station and loading into cars, are not taken into account,

which at 50 cents for the former would bring the average cost per ton up to $2.09⁴.

Then again the last column of figures is made upon the basis of 2,240 ℔s. to the ton, and to reduce this to 2,000 ℔s. to the ton for comparison with table No. 1, the average price received per ton would be about $2.50, and the cost per ton of 2,000 ℔s. about $1.96.

This would give a profit of 54 cents as against 40 cents in the first table; but then again the figures in table No. 2 are compiled through a comparatively short period of mining. In either case, an average idea of the value of this tract will be obtained.

The average thickness of the ore body (soft ore) in the Guiterman mine (Gehman property) is 13 feet.

Assuming this average in the Bittenbender tract, there is in the entire district an ore body 3,000 feet long, 130 feet (average) deep, and 13 feet wide, giving in round numbers 5,000,000 cubic feet of ore.

The P. & R. C. & I. Co. have determined its weight per cubic foot to be 93.61 ℔s., which at 2,000 ℔s. to the ton, would give a total tonnage of 234,000 tons, a result agreeing closely with the above figures in table No. 1.

Prior to 1880, all the Siesholtzville ore was delivered by teams at Red Lion Station, C. & F. R. R. As high as 40 teams were engaged at one time, for which from 30 to 50 cents per ton haulage was paid. In that year the "Pennsylvania Transportation & Improvement Co." erected a system of tramway from the mines to the railroad station, upon which the ore was carried @ 35 cents per ton, effecting a saving of about 15 cents per ton.

This saving, however, was only an apparent one, for the tramway was not a success, owing more to fault of construction than fault of system.

The numerous breakages and consequent delays more than counterbalanced the difference in price of transportation, so that the old wagon system was again resorted to.

When the errors of construction had been corrected, and the tramway once more in working order, the mines were abandoned; the tramway was soon removed to New York,

where, with better construction, it is said to be giving entire satisfaction.

In this year, 1880, some little work was done by Geo. Hess and others, on the wedge-shaped tract belonging to J. B. Gehman heirs, and mentioned on page 287. A shaft was put down and 1,000 tons are said to have been mined from workings 100 feet deep and 40 feet long, though there is a probability of their having trespassed over their line.

The following are some analyses collected from various sources, of the two grades of ore mined on the Gehman tract, (Guiterman & Gehman banks), which will show the general character of the ore. These are principally freedom from sulphur and phosphorus, carrying in round numbers about 43 per cent. Iron in the soft variety, and about 25 per cent. in the hard, and between 1 and 2 per cent. metallic manganese. The gangue is generally composed of the silicates of lime, magnesia and alumina.

	1.	*2.*	*3.*
Metallic iron,	24.650	41.900	27.250
Metallic manganese,	1.534	2.478	.619
Alumina,	1.501	3.787	
Lime,	25.410	3.880	
Magnesia,	4.396	1.048	
Sulphur,	.312	.175	.154
Phosphorus,	.024	.055	.058
Silica,	10.100	18.610	34.010
Phosphorus in 100 parts iron,	.097	.131	.212

These samples were all analysed by McCreath, dried at 212° F.

No. 1. Guiterman mine, *hard ore.* Sampled by McCreath, 115 pieces.

No. 2. Guiterman mine, *soft ore.* Sampled by McCreath, 20 pounds of ore.

No. 3. Gehman bank, *soft ore.* Sampled by myself, 15 pounds of ore.

No. 3 is from the opening at the most eastern extremity of the property and was taken from an old ore pile, which had been last removed from the lower workings of the mine. This pile was very dirty and greatly mixed with gangue

rock, which will probably account for the large amount of silica and small percentage of iron.

	4.	5.	6.
Oxide of iron, (Fe_3O_4,)	36.136	66.643	53.314
Alumina,	3.464	2.909	2.327
Silica,	9.24	17.530	14.020
Manganese oxide,	1.95	2.010	1.608
Lime,	26.10	1.990	1.592
Magnesia,	4.36	2.389	1.911
Carbonic acid,	18.36		
Water,	0.324 (diff)	6.600 (combined)	25.28
Phosphoric acid,	0.066	0.181	0.145
	100.000	100.252	100.197
Metallic iron,	25.295	46.65	37.32
Metallic manganese,	1.510	1.556	1.246
Phosphorus,	0.029	0.079	0.063

Nos. 4, 5, and 6 analysed by P. W. Shimer for Thomas Iron Co., Lock Ridge furnace, Alburtis, Lehigh Co.

No. 4. Guiterman mine, *hard ore.* Sampled at wharf Jan. 11, '79.

No. 5. Guiterman mine, *soft ore*, dried at 100 C. Sampled at wharf Jan. 11, '79.

No. 6. Guiterman mine, *soft ore*, as charged into furnace in wet state. Sampled at wharf Jan. 11, '79.

	7.	8.	9.	10.
Oxide of iron, (Fe_3O_4,)	——	39.33	26.57	61.13
Alumina,	14.00	11.67	6.23	7.57
Lime,	2.6	25.17	46.60	1.25
Magnesia,	2.0	7.91	6.48	trace
Silica,	23.25	13.82	13.85	19.80
Water,	——	——	——	9.10
Metallic iron,	43.00	27.53	19.23	42.79

No. (7.) Guiterman (fine ore), E. F. Cook, Warwick I. Co., Jan. 1, '82.

No. (8.) Guiterman (bottom ore), E. K. Landis, Pottstown Iron Co., April 1, '81.

No. (9.) Guiterman (clean lump hard ore), E. K. Landis, Pottstown Iron Co., April 1, '81.

No. (10.) Guiterman (soft ore), E. K. Landis, Pottstown Iron Co., April 1, '81.

Magnetic iron ore has also been found in Hereford town-

ship, at Huff Church, and on the hog-back ridge west of Treichlersville, but in neither place has it been greatly developed. Both the samples secured show a titaniferous magnetite.

Before proceeding west on this range a short description of the *Shimersville mine*, in Lehigh county, may be in place, inasmuch as it is believed by many to be a direct eastern extension of the Siesholtzville ore body.

This mine is on the Lehigh mountain a few hundred yards south of Shimersville, and about 2½ miles S. E. of Millerstown (Macungie), on the E. P. R. R.

The property is owned by Henry Riegel, and has been leased and worked since 1881 by Geo. Greis, of Alburtis.

This ore is a *red hematite*, giving a distinct red streak, though with a metallic luster and resembling magnetic iron ore.

The country rock is a quartzose feldspathic gneiss, in which very little mica occurs, and carries pyroxene in specks.

Both the soft and hard ore are found in the mine, the ore bed varying from two to six feet in thickness, having a foot wall of white decomposed granulite or feldspathic rock so soft as to be easily cut with a knife, and a hanging wall of chloritic slate (Potsdam?). The dip of all three is conformable about S. 70° E. 50° to 60°.

The mine is worked by two shafts, the first or more southern one proving so weak as to cause its abandonment and the location of the new or north shaft. The old shaft is 70′ deep, and is supplied with a 36 horse-power engine and 4 levels. The new shaft is carried down 125 feet, in which depth there are two levels, one at 90 feet and the other at bottom of shaft.

No stoping had been done at time of visit (September 28, 1882). The production was about 450 tons per month, which all went to the Macungie Furnace at present, though the Crane Iron Co. formerly used some of it. Employs 22 men, and pays 55 cents per ton haulage to Macungie (2½ miles).

The following is an analysis of mixed hard and soft ore,

dried at 212° F., by A. S. McCreath, from a sample sent him by myself; sampled at mine:

Metallic iron,	56.200
Sulphur,	.003
Phosphorus,	.081
Silicious matter,	11.350
Phosphorus in 100 parts iron,	.144

The ore runs very regularly, though some difficulty is experienced in its extraction, owing to the great amount of water.

A. M. Weaver, Supt. Macungie Furnace, reports the general average of hard and soft ore together, from samples taken once a month through a period of 10 months, to give Iron 56.6 per cent., Silica, 11.66 per cent., a result agreeing closely with McCreath's analysis, and showing the persistent character of the ore.

I don't consider the mine any more closely related to the Siesholtzville ore than the group of Red Hematite mines at Zionsville, in the valley of the Indian creek, which have the same characteristics in foot and hanging wall as the Shimersville mine, and show the same general percentage of ore and gangue.

The following is an analysis of the Schoenly mine (one of that group), made from a number of mixtures, *undried*, taken from the cars during July and August, 1882; H. Y. Seamen, chemist:

Fe_2O_3,	83.60
Alumina,	.07
Lime,	.17
Magnesia,	.58
Silica,	6.16
P_2O_5,	.249
Metallic iron,	58.52
Metallic manganese,	1.85
Phosphorus,	.109

Washington Township Magnetic Ore Mines.

This township, immediately adjoining Hereford on the south-west, shows a close resemblance to it in its Laurentian rocks, but has shown several varieties of magnetic ores totally different from those in Hereford. None of the soft

ore of the Siesholtzville district has been found here at all, and lime is absent as a principal gangue constituent.

The chief mine in the township is the

Landis Mine

at Barto Station, Colebrookdale RR., which has been worked for many years.

It is located on land of J. Landis, just north of the public road to Bechtelsville and about 500 yards west of the railroad station.

It was first opened about 18 years ago by Wm. Rowe, Sr., for the Grove Bros., of Danville, Pa., who had a lease on the property (about 50 to 60 acres.)

Since 1871 Mr. Wm. G. Rowe, of Reading, has been operating it under a sub-lease from Grove Bros.

There are two shafts on the property, the smaller and newer one (No. 2) being about 35′ N. W. of the old or No. 1 shaft.

There are apparently two beds of ore, the smaller or "back bed" being about 35′ N. W. of the larger or "front bed," though from present indications it is probable that they will meet in the lower levels and form one body of ore. At all events the "back bed" has much the steeper dip of the two.

The "horse" of rock dividing the two, forming the foot of the front bed and hanging of the back bed—a coarse granitic rock with large crystals of pink feldspar—is not considered a true foot wall, as it carries frequently a considerable amount of ore.

This is particularly well seen about 200′ down from the surface in the workings of the old mine, and again illustrates the frequent bulging of the ore body and its formation into the lenticular-shaped masses shown on Fig. 11, page 191.

Here, immediately N. W. of the shaft, the foot wall takes the shape of an inverted W in the loops of which the ore occurs, increasing the local thickness of the ore on a 45° dip to nearly 40 feet.

When first visited in May, 1880, this shaft, under the

superintendence of H. G. Taylor, (now of the Island mine, Reading,) had been carried down vertically 116 feet through the hanging wall, a light grey syenite, the outcrop of the bed being in the open cut against hill side north of the shaft, where some outcropping ore had already been removed.

At the surface the ore showed a dip of S. 15° E. 70°, which decreased at 116′ to about 45°.

A slope was sunk from 116-foot level on the ore for 100 feet, from the bottom of which a gangway 130 feet long had been driven along foot wall to the west.

In this direction the ore seemed to pinch out and become very much mixed with hornblendic rock, which did not pay to mine.

At that time, as at present, the principal consumer of the ore was the Montgomery furnace at Port Kennedy, whose manager, Mr. John W. Eckman, writes me under date of Nov. 2, 1882, that "he considers the ore a 50% ore and easily worked after roasting."

The following analysis accompanied his letter:

Silica,	10.3100%
Oxide of iron,	78.1160
Alumina,	0.9220
Lime,	9.4660
Magnesia,	0.1210
Manganese oxide,	None
Sulphur,	1.0670
Phosphoric acid,	0.0814
	100.0834
Metallic iron,	=56.482%

The No. 2 shaft on "back bed" was then idle. When next visited, Oct. 19, 1882, Robert Laidy, boss, the old shaft had been carried down to 300 feet, where a *30° dip* to the S. E. prevailed; but no active work was being carried on in that level, which was being used for collecting the ore that came down through the shutes from the stopings and carrying it thence to the shaft.

The ore in descending had become exceedingly hard and carried an appreciable quantity of sulphur. Indeed, pyrite crystals are disseminated throughout the mass.

The "front bed" varies from 6′ to 30′ in thickness,

though as already said, the deposit is in lenticular-shaped bodies of no regularity whatever.

From the middle level a drift was driven north-west to prove property. It is 35′ long, and struck a 6′ bed of ore (the "back bed"), dipping to the south-east about 50°.

In stoping out this bed a large fall took place, completely choking up the workings, and for a while stopping mining in that quarter.

Recently, however, the stopes have been re-opened, and the ore is being won by timbering up small manways, and sorting the ore from the great quantity of micaceous dirt that came down with it from the open cut.

A gangway has been driven *east* on this bed from the drift, and has struck the No. 2 shaft workings at 140′ from surface.

The width of this bed varies from 5′ to 15′, though often pinched out altogether.

No. 2 shaft is driven 60 to 65 feet through rock—the divide between the two beds—and 80 feet through ore and foot wall.

On account of the great swelling in places no timbering could be used, so that large pillars of ore 15 feet thick have been left to sustain the workings.

One of these pillars containing a valuable quantity of excellent ore is immediately behind No. 1 shaft, and cannot be robbed for fear of endangering the safety of the works.

The position of the shaft is unfortunate, as well as its change into a slope in the lower levels, preventing systematic stoping in the mine and necessarily entailing a great loss of ore.

Fifteen tons a day was the average production when visited though its capacity is greater if need be.

The ore brings $4 75 per ton and is loaded on cars of the Colebrookdale RR., at the company's wharf at Barto Station. The mine gives employment to 24 men. 20 to 24 tons of coal @ $3 50 are used during a month. Most of the water is surface drainage, though there is a great deal of it,

each shaft having a 30-horse power engine pumping night and day.

Mr. McCreath has made two analyses of this ore, one from his own sampling of 150 pieces in 1881 and one from a careful sampling at the bank by myself in the fall of 1882. They show:

Metallic iron,	46.100	47.650
Sulphur,	1.048	1.245
Phosphorus,	.083	.087
Silica,	19.700	17.580
Phosphorus in 100 parts iron,	.180	.182

These were both dried at 212° F. and fairly represent the character of the ore at time of sampling.

The following are some additional analyses furnished by the Pottstown Iron Company:

	1.	2.	3.	4.
Oxide of iron,	65.70	73.72	67.60	68.00
Al_2O_3,	7.40	7.33	6.80	7.35
$CaCO_3$,	9.10 (CaO)	5.00	5.95	2.96
$MgCO_3$,	0.40 (MgO)	1.00	2.95	2.54
SiO_2,	17.20	10.65	14.30	17.85
Metallic iron,	47.60	53.37	49.01	49.20

These analyses are all by E. K. Landis, chemist for the company. No. (1,) January 25, 1880; No. (2,) November 2, 1881; No. (3,) December 2, 1881; No. (4,) March 11, 1882.

A short distance south-west of the Landis mine, and just south of the public road, there is an abandoned ore shaft without indications of any ore having been found there. Close by, on the road, there is an outcrop of syenite dipping S. 45° E. 50°.

To the east of the Landis mine, and close to the Shultzville road, there is another opening on the bed in the

Barto Mine,

situated on land of Abraham Barto, 300 yards north-west of Barto Station and about the same distance north-east of the Landis mine.

When visited October 19, 1882, no ore was being raised,

pumping having been carried on all summer, probably with the intention of disposing of the lease.

The mine is an old one; the shaft is 150 feet deep with a gangway at 100 feet.

From bottom of shaft there is a cross cut north-west which cuts two beds, one at 45 feet 5′ thick and the second at 60 feet about 6′ thick.

There is a gangway north-east and south-west on north or "front bed."

The south-west gangway is probably 50 feet long, and stoping has been carried up here to the 100′ level.

This work was done by Brooke, of Birdsboro, who reports having abandoned the mine about 1876 after 3 years' working.

Mr. James Gayley, of this company, says they had a 250′ shaft, and had stoped out several thousand tons of ore.

They had also put down a winze on the ore from the bottom level 75-80 feet, which showed ore, but not enough to warrant work, the ore becoming very much squeezed out and much mixed with rock, requiring careful picking to get an article worth shipping. This is the first instance reported that "the vein did not grow larger as it went deeper."

An approximate analysis of this ore was: Iron 38–40%, Phosphorus 0.6–0.7%, Silica 10–12%.

This bed outcropped on north side of public road, and a shaft on it there was formerly put down by the Pottstown Iron Co., the first lessees.

Messrs. Young and Dowdy now hold the lease, and have carried the north-east gangway on front bed out 30 feet, but had done no mining.

The ore occurs between syenite, dipping about 65° to the south-east, though this dip decreases in the lower level similarly to the Landis mine.

The ore seems very hard, and in hand specimens seen seems comparatively free from sulphur.

Going up Swamp creek from Bechtelsville there are several openings in the Laurentian gneiss hills. The first one met with is the

Stouffer mine,

on the Benfield property, about ½ mile north of Bechtelsville.

The shaft is located in valley at base of small hill over which the road passes to Hill church.

The mine was idle during the many visits I paid to the region, but it has been recently cleared up (March, '83.)

Mr. Harden, General Mining Engineer for the Phœnix Iron Co., recently made an examination of the property, and forwards the following notes of his general observations:

The shaft was originally sunk to the depth of about 50 feet in the vein material, but not finding hard ore they drove *south* (this direction being the strike of the bed), with no better effect.

They then drove two drifts east and west and still found no hard ore of any importance.

It was then thought best to sink a winze from point on main gangway where side drifts had been driven, which was presumably driven prior to the sinking of the main shaft.

They found the hard ore and followed it down the dip about 25 feet, and at this distance they turned west horizontally some 8 or 10 feet and struck hanging wall dipping in the same direction, namely, to the west.

The vein material is probably 18 to 20 feet wide.

The ore sample on dump of some 100 to 200 tons is, in Mr. Harden's estimation, quite unsaleable, carrying from 30 to 40% iron, but a great deal of quartz, feldspar, and hornblende.

Mr. McCreath sampled this ore in 1881 in company with Mr. Jacob Gilberg and reports the following results:

	1	2
Metallic iron,	38.900	33.450
Sulphur,	1.030	.039
Phosphorus,	.106	.141
Silica,	23.130	31.880
Phosphorus in 100 parts iron,	.272	.421

Both samples were dried at 212° F.

No. 1, hard ore, 105 pieces. No. 2, soft ore, 15 lbs.

The ore is likewise titaniferous, a recent partial analysis, by Chas. I. Rader, of the Phœnix Iron Company, showing as high as 6.68 per cent. titanic acid.

At present all the explorations have been carried on in the line of *strike* instead of the *dip*, which latter is about 60° to 65° west.

At apex of slope there is a small steam pump, and on top a 6″ bucket pump. They pump probably 50 gallons of water per minute.

Further up creek about ½ mile, and just east of J. Dotterer's house on hill, there is another opening, known as

Gilbert's Mine.

This opening has been but slightly developed, and consists of two or three small open cuts and one shaft about 50 feet deep.

The ore is a tough titaniferous magnetite with a bright luster, but fully one half of that taken out of the mine is composed of nodules of a white soda feldspar, rendering the ore very refractory. It was tried in the Bechtelsville furnace, where it was said to make a good, tough iron ; but the slag formed from such a large quantity of silicious matter was very hard to work off, and could be spun out like so much glass.

The mine was idle when visited, but was again put in operation about December 1st, 1882, by its former lessee, E. Lewis, of Eshbachville. The ore occurs between walls of the hardest syenite all dipping S. 35° E. and 38°.

Mining is expensive, and the ore must be very carefully sorted before using. The following analyses are furnished by the Pottstown Iron Co., and their varying quantity of iron shows the irregularity of the ore:

	1	*2*	*3*	*4*
Metallic Iron,	49.64	24.81	38.2	31.96
Al_2O_3,	12.00	19.2	13.4	11.8
$Ca\,CO_3$,	trace	2.5	2.1	2.1
$Mg\,CO_3$,	——	——	1.7	——
Silica,	19.45	42.95	28.5	41.36

No. 1, E. K. Landis, chemist, Feb. 10, '81. No. 2, June 21, '81. No. 3, June 6, '80. No. 4, Feb. 4, '81.

Ore of the same character is found further up the valley at the headwaters of Swamp creek, at

Gilberg's Mine,

located about 1½ miles north-west of Barto Station, on continuation of same hill as Gilbert's mine and about ¾ miles north-east of it.

It is in cove on property of E. Nestor, owned now by J. Gilberg and D. Benfield.

The mine has been in operation, with various interruptions, for about 15 years, and worked since 1880 by Gilberg.

Like most of the mountain mines it was idle during the season of 1882 when visited, though there was considerable ore on the dump.

This was magnetic and titaniferous, filled with feldspar chunks, as at the Gilbert mine, but apparently of rather better quality and not requiring as much sorting to free it from gangue.

Shaft seemed about 80′ deep and is provided with a good engine house and 25-horse power engine. Costs 40 cents haulage to Bechtelsville, 2½ miles, from where it was shipped to the Pottstown Iron Company's furnace, who used most of the ore.

It makes a tough iron suitable for boiler and sheet-iron and nails. Apparently not much water.

Ore occurs in hard syenite and dips about S. 30° E. 40°.

The following is McCreath's analysis of sample, 140 pieces, sampled by himself and dried at 212° F.:

Metallic iron,	49.500
Titanic acid,	9.650
Sulphur,	.007
Phosphorus,	.021
Silica,	16.900
Phosphorus in 100 parts iron,	.042

The only other openings of magnetic ore in this township are located in the hornblendic gneiss hill east of Dale Forge and just south of the Churchville road, known as *Sparr's mines* and the *Eline mine.*

The first are on property of J. Sparr, of Churchville; consist of a couple of small windlass shafts and show a mixture of hornblende and small magnetic ore pieces on dump, the former largely predominating.

It was idle, and last worked by Geo. Greis, of Alburtis. It is reported opened nine years ago by Robert Hobart of Pottstown, and Harry Nauman of Reading, who shipped a few car loads to New Providence, Lancaster county.

The *Eline* mine has the same general characteristics and was opened in 1877 by Thomas Gay, of Pottstown. The region so far is not a promising one.

There is an old shaft sunk close to creek in the south-west corner of the township, south of J. Dotterer's place on the Hill Church road.

Nothing could be learned of this project, but the dump showed several tons of a highly-crystallized hornblendic rock called "Black Jack" by the miners.

The rock dips east about 46° and shows but little indications of ore. The hill in the south-east portion of the township, which is a mixture of trap and indurated New Red shale and sandstone, has been riddled with holes during the era of the old charcoal forges, though nowhere worked at present. Some good cabinet specimens can be had here.

Pike Township Magnetic Ore Mines.

This township has never been a great magnetic ore producer, and at present it does not add a single ton to the annual product of the South Mountains.

It, however, shows several mine holes, and in the past it may have furnished some quantity of ore. On the property of Lewis Rohrbach, in the northern part of the township, there is a 100-foot shaft, and a tunnel into hill 150 feet long; but as far as I could learn there is at present only about 2′ of ore. Further south, near S. Yoder's house, there are several ore holes on hill in hornblendic syenite, and a tunnel 200 feet long into them from the public road. No work has been done here for 7 or 8 years, the last mining having been carried on by the Clymer Iron Co.

Considerable ore is said to have been taken out of here

for the old Rockland Forges, but nothing could be learned of its character or amount. Rogers, on page 716, Vol. II, refers to an opening ½ mile S. E. from Lobach's mill on Pine creek, "the ore having the aspect of a talcose slate, charged with oxide of iron, with a laminated and rather fibrous structure," but this has long since been abandoned.

A considerable amount of ore is likewise said to have been taken out of the abandoned ore holes on the Lobachsville-Hill Church road, about ½ mile south of Lobachsville; but this was probably a red hematite, as this part of the hill is composed almost entirely of Potsdam and a gneissic conglomerate similar to that at the Dotterer, Saw Mill hill, "Red Oxide mine," in Earl township.

There is likwise an old shaft down on N. Heydt's property, up the west branch of Pine creek, and north of C. Miller's house. The gangue is mostly hornblende, and the dump shows very little ore.

Earl Township,

being fully one half composed of Potsdam sandstone, has but a limited area of Laurentian rocks, and shows but one old abandoned ore shaft on hill about 1 mile N. W. of Shanesville, belonging to Isaac Cleaver.

The dump shows a black hornblendic syenite, and what little ore there was seemed to be massive and of good quality.

The only remaining magnetic mines to be mentioned are those occurring along the northern border of the Mesozoic sandstone formation from Boyertown to Fritztown—all similarly located, and occurring under identical circumstances, so that they can be treated as a whole under the name of the

Southern Range or Conglomerate Series.

The first in importance, the oldest and the best developed, are located at the eastern edge of the range in the borough of Boyertown, where practically the first exposure of Mesozoic conglomerate is met with.

The Boyertown deposit can be treated as a whole, for

while it is not possible to determine the precise relationship of the ore bodies in the various mines there, the circumstances of deposition are sufficiently analagous to permit of many generalizations.

A carefully prepared map of this region has been drawn and compiled by Mr. J. H. Harden, of the Phœnix Iron Co., from original surveys and data furnished by the Warwick and Gabel Companies. See Atlas.

It has not been possible to learn anything definite about early mining here, but the limestone valley in which all these ores are found seems to have been first worked by open cuts on outcropping ore near the site of the present Lower Phœnix slope, though most evidences of this kind have been long since covered up

Several thousand tons are said to have been taken out of the meadow on the Rhoades estate, and the direction of outcrop seems to turn S. W. along the Ironstone creek, between the trap dykes, and N. E. to the Lower Phœnix slope, the old "California mine."

While the ore in this mine certainly bears some relation to that found in the Gabel mine, especially in that ore known as the "blue bed," there exists so much local contortion and irregularity everywhere that no attempts to connect deposits of similar constituency and character by courses of gangways were successful.

In the Gabel and Warwick shafts such a connection, owing to the *geologically* fortunate trespass of the latter company, is rendered apparent, and the "black ore bed" or upper bed is identical in the two mines.

The "blue ore bed," found in the lower level of the Gabel mine about 150 feet beneath the black bed, certainly shows a close analogy in its general character and bearing to the "Rhoades vein," in the Lower Phœnix slope, but as yet has not been found in the Warwick shaft at all, though drifted for in a cross cut 150′ long.

Owing to the inferiority of this blue bed, most of the mining in these two shafts has been carried on in the upper or black bed, and a glance at the mine map will show the tendency of this ore bed to swing around the nose of Gabel

hill and back on to its eastern flank under the Mesozoic shale.

The black ore found in the Lower Phœnix slope shows absolutely no connection with that in the two before-mentioned shafts; nor does it show any parallelism in structure to the "Rhoades vein" or blue ore found in the southern portions of the workings.

The dips in all these mines are universally to the south, south-east, or south-west, declining in strength in that direction, and on this evidence in the Gabel and Warwick shafts the black bed should outcrop about 100 feet west of the Mineral Reserve line, in the meadow near the marble monuments, thus making the black ore or "Hagy vein" (which outcrops in the large open working at Eckert's slope) a lower bed.

I do believe, however, that through the 700 feet of unproved territory between the Phœnix Middle slope and the abandoned Eckert workings, there is a very possible connection between the "Hagy vein" and the ore body found in the two northern slopes, though there is an apparent pinching out of ore at both places.

It is, I believe, the intention of the Phœnix Iron Company at no very distant day to drive through this property upon which they hold mineral rights, and such a day will be anxiously looked forward to by the many interests represented in this region, which is only beginning to be intelligently understood.

Until within a very recent period of time no mine maps of the numerous gangways existed in any of the companies' offices, and even the results of work in that direction presented on the map accompanying this report will show how singularly deficient and careless the owners of these valuable ore tracts have been.

The law suit growing out of the trespass of the Warwick Company on the Gabel property, and the robbing of 8,000 tons of excellent ore, established the utility of accurately prepared maps of the various underground gangways, and the mutual interest of the various parties engaged in min-

ing there, will, it is hoped, render an occurrence of this kind impossible in the future.

At the time of preparation of this map all the Phœnix Company's slopes were idle and filled with water, and as no accurate records of their various gangways had been kept, it was impossible to more than indicate the different levels with the addition of such data as had been secured by Mr. Harden when instructions to "shut down" were issued.

By February 20, 1883, the lower slope had been once more pumped out, and, though still wet and dirty, I took occasion of the circumstance to pay my first visit to it.

I may further add that additional regret was occasioned by the impossibility of having analyses made of a suite of rock and gangue specimens of foot and hanging walls, rock "horses," etc., selected from the various mines.

It seemed to be no one's duty to perform, Mr. McCreath having his hands full with the ores, limestones, and coals from various parts of the State, and Dr. Genth's services being no longer available.

I can, therefore, only present such results as were obtained by personal inspection and the testimony of the officials of the different companies.

Phœnix Lower (California) Slope.

The land upon which the workings of this mine are located is owned by Lewis Bros., of Philadelphia, and Messrs. Hagy & Rhoades, from whom the Phœnix Iron Co. have leased the mineral rights.

The contract with Lewis Bros. was drawn up 30 years ago, and expired on November 26, 1882, though the mine had been in operation before that time.

At the present time, (February, 1883,) the southern portion of the tract south of the property line in black belonging to Hagy and Rhoades, had not been re-leased, and the company were erecting offices and ore wharves north of that line, with a view to carrying on operations on the Hagy vein alone, in conjunction with idle property to the north formerly worked by Eckert, of Reading, in which the Phœnix Iron Co. have a joint interest.

The developments here consist of 36° slope about 300 feet long, with a 10-foot water sump at bottom. The bottom of the slope is 206 feet *vertically* below level of top of slope as computed from elevations furnished by Mr. Harden.

The different levels in this mine, as in the other mines of the district, are shown by different colors, the *blue* always representing the top level in each individual mine; the *black* the middle level, and *red* the lower level.

North from the slope three gangways have been driven on the Hagy ore bed.

The lowest of these, colored red, was driven first about 50′ through a dark quartzose sandy rock, of a bluish color, probably referable to the amphibole group of rocks, consisting of the silicates of alumina, lime, iron, and magnesia; though hornblende, the best known variety in this group, is not conspicuously present.

Thinking the course of gangway was turned too much towards the east to strike the ore, the next 50′ was driven more to the north—through rock, likewise—until at a distance of about 110′ from foot of slope, ore was struck. The original N. E. course was again resumed, and carried entirely through ore for 50′ more.

The gangway at the time of my visit showed a chamber fully 22′ wide without showing foot or hanging walls, having apparently followed course of bed for the last 50′. Of course no dip in this vast body of black ore could be obtained, though it is probably a little east of south, and at a steep inclination.

A small rise was being started on the *north* side of the gangway at its N. E. extremity, with a view of stoping up to middle level.

The middle drift (grey) is about 40′ vertically above the lower gangway, and in driving north from shaft the same characteristics were met with as already noted in the lower level.

It, however, shows a striking want of parallelism with the lower level, turning much more decidedly to the N. E. The first 30 feet here was also in rock, after which the ore body was met with in a rather pinched condition.

Just east of this point a rise has been put up vertical, and is at present about 40 feet above level of gangway, and on south side of it.

At this height a large bunch of excellent ore was met with, about 16 feet thick, whose foot wall seems to have a steeper inclination than the hanging, and with a slight tendency to pinch the ore in rising.

It is the intenion of the engineer to carry on this stoping until pinched off by rock; but at present it looks as if a considerable distance must be driven before that event occurs.

The foot wall seems nothing more than a "horse" of rock —a feature frequently met with in these mines, but in this case assuming large proportions—dividing the main body of the ore found in the gangway below. But it is now thought at the mine that this is an entirely different body of ore from that found below.

This opinion I do not share.

Singularly though, this rise is fully up to the height of the upper level, and with very little inclination to turn over north towards the upper level.

The upper level is not shown on map, but is driven north from slope at same level as upper rock tunnel colored blue, and about 176 feet vertically below surface of ground.

It extends probably 80 feet along south line of Eckert's open cut, with a tendency to enter across property line; and the circumstances are such as to prevent anything like economical mining unless the two parties mutually interested (Eckert & Phœnix Iron Co.) can agree on some basis of mining all the ore here by a system of stoping and pillar robbing from the Phœnix drift. The ore body pinches going N. E. in the open cut, though it is of the same general character as the ore found in the lower drifts.

These characteristics present an excellent hard, compact, massive magnetic ore, with a sub-metallic luster, very slightly crystallized, practically free from phosphorus, and carrying less than 1 per cent. of sulphur.*

*Oxidation is prevalent even in the lowest depths of the mine, Mr. Harden having recently sent me specimens which show a plate covering $\frac{1}{8}$ of an inch thick, consisting of scales of red and brown hematite.

The ore body is much more homogenous than that found elsewhere in this district, and makes an excellent iron. I present below three analyses of this ore: No. 1 by Mr. Chas. I. Rader, Blast Furnace Manager Phœnix Iron Co.

No. 2 by Mr. A. S. McCreath, sample selected by Mr. J. H. Harden from recent developments, (April 20, 1883,) dried at 212° F. Mr. McCreath writes that "this ore is very different from that in the pile from which I selected sample, being nearly all hard lump."

No. 3 by Mr. A. S. McCreath, sample dried at 212° F., and selected by him (175 pieces) from pile at the Phœnix Furnace, Phœnixville, in 1881.

	(1)	(2)	(3)
Silica,	20.34	8.500	17.380
Alumina,	5.00		——
Lime,	5.94		6.080
Magnesia,	6.24		7.027
Sulphur,	0.47	1.673	0.685
Phosphorus,	trace	.053	.022
Phosphorus in 100 parts iron,	——	.096	.052
Metallic iron,	42.66	54.850	41.800

It may be as well to state that this ore has always been held as a 50 % ore by the company. I have no doubt but that much of it will show such a percentage of iron through periods of mining.

But there is no persistency whatever in the run of any of these magnetic ore bodies as already explained at the beginning of this chapter. The above analyses will demonstrate that fact, and analyses would have to be made weekly to show all the variations in this deposit. The three presented no doubt show the character of ore mined at time of sampling, which is all that is claimed for them.

It is to be regretted that a few additional analyses of this ore could not be procured, for it is well spoken of and has been largely used at the Henry Clay furnaces, Reading, and at Pottstown, in addition to the Phœnix Company's own furnaces.

Exploration has also been carried on south of the slope, where the workings consist of a rock tunnel driven southwest for about 200 feet from upper level, 176′ (?) below sur-

face, through a mixed micaceous and quartzose rock to the Rhoades' vein of "Blue ore," which strikes about S. 25° E. and dips a little east of north 50°.

A similar rock tunnel has been driven from the middle level, black, in a nearly parallel direction, and from its extremity a winze has been put up to strike "Rhoades' vein" in upper level.

There is a fine face of ore 30 feet thick exposed in this middle level, ready for mining at any time; but owing to the inferior quality of this as compared with the Hagy ore, work has been suspended in this part of the mine. Nor has the lease been renewed up to time of writing (February 23, 1883.)

The thickness of this ore bed varies greatly as is the case throughout all these mines.

Its gangue is very similar to the Hagy ore, being mostly silica, lime, and magnesia.

The ore is leaner in iron and carries more sulphur and a little copper, and is identical in composition with the blue ore in the Gabel mine, which it also resembles in physical attributes.

But while the blue ore in the Gabel shaft is separated from the overlying black by about 150′ ± of impure limestone, the two beds in the Phœnix mine are divided by rock which is apparently a rotten quartzose gneiss, though the ore gangue itself is largely limestone.

The following is a complete analysis of this ore by Mr. McCreath, dried at 212° F. Sample, 20 lbs., from ore pile at Phœnix furnaces, 1881:—

Bisulphide of iron,	2.807
Protoxide of iron,	14.657
Sesquioxide of iron,	31.200
Protoxide of manganese,	.269
Oxide of cobalt,	.030
Sulphide of copper,	.251
Alumina,	4.325
Lime,	10.090
Magnesia,	7.963
Sulphuric acid,	.150
Phosphoric acid,	.078
Carbonic acid,	.815
Water,	1.500

Alkalies and undetermined,	4.655
Silica,	21.210
	100.000
Metallic iron,	34.550
Metallic manganese,	.208
Metallic copper,	.167
Sulphur,	1.641
Phosphorus,	.034
Phosphorus in 100 parts iron,	.098

A comparison of this analysis with that of the Hagy ore, sampled at the same time, will show the marked increase of sulphur and phosphorus in the Rhoades ore, as well as the decrease in iron percentage.

This analysis will, moreover, furnish a ready comparison with the Gabel blue ore (see page 331), which it strikingly corresponds with in composition.

The blue color in the Rhoades ore is due to the salts of copper, which have so conspicuously marked it as to give to it its local name.

A large quantity of this ore (probably 5000 tons), which has been lying on dump at mine, has been recently sold to the Norway furnace, at Bechtelsville, where it is being used in equal amount with the blue ore from the Gabel shaft.

The following table will give some further analyses of this ore, showing its average quality through the run of the mine, kindly furnished by the Phœnix Iron Co. and Pottstown Iron Co.:

	1. Oct. 26, '79.	2. Lump ore, May 6, '80.	3. Fine ore, May 7, '80.	4. Average, Feb. 8, '81.	5. Lower level, Sept. 11, '81.	6. May 6, '82.
SiO_2,	29.15	28.45	27.32	29.97	26.57	26.35
Al_2O^3,	8.16	8.20	7.23	7.20	....	10.52
CaO,	12.20	11.60	13.11	10.17	....	8.57
MgO,	3.99	5.61	3.99	....	....	7.65
Sulphur,	1.20	1.20	1.43	1.02		
Phosphorus,	.036	.03	.03	.04		
Iron,	32.41	31.70	33.45	31.11	30.75	29.56

Phœnix lower slope ("California mine"), Rhoades' vein (blue.)

Nos. 1-5, Chas. I. Rader, Phœnix Iron Co.

No 6, E. Landis, Pottstown Iron Co.

In comparing these analyses with McCreath's it will be noticed that they all give a larger percentage of silica and a smaller amount of metallic iron, but all show the general run of the ore.

This mine, when in running order, furnishes an output of about 50 tons a day, or about 15,000 a year.

About 20 men are employed there under the superintendence of Mr. Richard Richards.

The ore is mostly lump, there being some little fine crop ore taken out of the cave hole on Rhoades' vein, shown on map.

The engine house is supplied with 1 pair 8x12 hoisting engines, and one 12x24 single pumping engine, with 2 sets 10 inch pumps.

The ore is hauled to the company's wharf at Boyertown Station, on the Colebrookdale railroad, ¼ mile, by contract teams, @ 22 cents per ton of 2240 lbs.

North of this mine about 100 feet there is an old engine house and slope, long abandoned, located on small plot of ground owned by Messrs. *Lewis & Eckert*, and in the mineral rights of which the Phœnix Iron Co. holds the larger interest.

A considerable open cut is shown here on the map, which is 200×100 by 35 feet deep, from which the Hagy ore has been mined on its outcrop.

The inclination of the bed to the south-east soon carried this ore into the adjoining property on the south worked by the Phœnix Iron Co., whose intention it is now to resume work on their upper level and carry their stopings into the Eckert opening, and rob the pillars of ore still left standing there. No information as to analyses or number of tons mined there could be obtained from Eckert & Co., though the yield could not have been very large.

As no connection has been established between this body of ore and the black magnetic ore found further north-east

toward Boyertown, the two upper slopes of the Phœnix Company put down there may be treated separately.

As already stated, 700 + feet of unproved territory intervenes between Eckert's open cut and the Phœnix Middle slope, situated on land of R. M. and L. Lewis, and comprising property between Walnut street and the Reading road.

It may be well to state that the "Mineral Reservation Line," dividing the Phœnix Company's rights from those of the Warwick and Gabel mines, extends down the center of the Reading road, passing through Station 47 shown on map, and continues in same direction a little west of the Warwick engine house. This line is shown on map in broken, dotted, and barred type.

The Phœnix Upper and Middle Slopes are 350 feet apart —outside measurement—and both work the same body of ore, averaging from 12 to 15 feet in thickness, though often swelling into bunches three times as large in different portions of the various gangways.

A much more regular dip is however, discernible here, averaging about 45° S. 45° E.

The upper slope is carried down 353 feet, and the bottom is the same distance vertically beneath surface, which latter is here 414 feet above ocean level.

The lower drift is driven off this slope from bottom about 150 feet each way, N. E. and S. W.; but the courses have never been surveyed, and consequently could not be located. It is, however, very close to the Mineral Reserve Line.

Forty-three (43′) feet vertically above this is the middle drift, colored gray, likewise driven each side of slope, about 160 feet to the N. E. and 300 feet *air-line* S. W. to middle slope.

The upper drift, blue, is 267′ below surface and 43′ above middle gangway, likewise driven each way, about 300 to the N. E. and 300 to the south-west, connecting with middle slope the same as in lower level, though not so shown on map, as the courses have never been surveyed.

The middle slope has the same elevation as the upper one,

414 feet, and is about 310 feet long with two levels corresponding with and connecting the upper and middle levels of the upper slope.

The upper slope was driven down on ore all the way, and as the ore body here is much softer than in the middle slope a great deal of trouble and expense has been necessary to keep this slope in repair.

This has consequently led to its proposed abandonment, and the erection of good permanent buildings at the middle slope (driven down in rock) from which all future mining will probably be carried on.

These improvements were hardly consummated when the dull times of 1881 led to the closing up of all these mines, and the two upper slopes are still filled with water.

It is likewise proposed here to further test property by driving north from slope to prove the presence or absence of the underlying "blue ore bed."

No knowledge of its outcropping behind the engine house is known, but the whole question could be decided at comparatively slight expense and would go far to establish the relationship (if any) between these upper mines and those occurring further west in the valley.

A comparison of the analysis of this ore with that of the "Hagy vein" in the lower slope evinces a considerable similarity of composition.

The true foot wall in both these slopes is an altered syenite, carrying thin seams of earthy magnetite, with dull luster, often massed or bunched and showing but little crystallization.

The syenite is filled with pink (orthoclase) feldspar nodules, hornblende, and epidote, all distinctly stratified.

In the upper slope, however, a dark-greenish black unctuous limestone layer is often found between the main body of the ore and the true foot wall, frequently carrying chert in large masses.

The top wall is a decomposed light greenish-grey serpentine limestone, slaty, and carrying crystals of pyrite.

The "ore rock" in these mines is generally an impure conglomerate limestone, carrying masses of dove-colored crystal-

line limestone, serpentine, and magnetic ore; but the bulk of it is a green to black dolomite with coatings of calcite.

The ordinary run of the mine shows a mixture of magnetic iron ore with limestone and minute crystals of iron pyrites diffused through the mass.

Occasionally the latter are bunched together, when the crystals are large and well defined.

The No. 1 ore from these mines is a fine earth-black magnetite, with partial crystallization and nearly free from sulphur.

Both soft and lump ore are found here, the former to a limited extent, and the following table, compiled from data kindly furnished by the Phœnix Iron Co., comprises analyses of this ore by Chas. I. Rader except No. 10, which is by McCreath, dried at 212°F. Sample 20 ℔s. ore.

1881.

	1. June 9. Old dump ore.	2. June 9. Newly mined.	3. Aug. 16.	4. Sept. 4. Middle slope.	5. Sept. 9. Upper slope.	6. Oct. 14. Upper slope.	7. Oct. 13. Middle slope.	8. Nov. 17. Middle slope.	9. Nov. 30. Upper slope.	10. Mixed.
SiO_2, ...	22.97	23.30	18.44	18.20	11.14	18.74	21.54	21.14	25.54	17.780
Al_2O_3, ...	14.81	12.76	15.97	3.27	8.03	7.86	6.01		7.22	.
CaO, ...	4.88	3.00	2 94	4.54	3.27	3.54	4.00	3.64	3.94	7.620
MgO, ...	7.16	7.10	1.00	4.70	3.87	2 55	3.20	3.22	7.25	8.591
Sulphur, ...	1.29	0.23	0.25	0.81	Trace	0.81	0.86	Trace	0.19	0.428
Phosphorus,	0.131	.100	0.13	.100	0.200	0.14	0.20	.150	0.03	0.025
Phosphorus in 100 parts iron, . .										.066
Iron, ...	37.37	39.29	41.10	47.23	49.79	42.44	43.48	43.48	37.63	38.000

These analyses show the variation in iron to be from 37.37% to 49.79%, a difference of 12.42%, and no better evidence can be adduced to show the instability of these ores.

The large percentage of alumina in most of the analyses will also be noted, as well as its varying amount.

The middle slope is well supplied with mining appliances, consisting of a pair of 8x12 engines, one 16x36 pumping engine, and 4 boilers, each 36x30.

Warwick Shaft.

Located on south side of Mineral Reserve line, is distant about 500 feet *air line* from Lower Phœnix slope, and immediately joined on the south-west by the Gabel property.

A considerable tract of ground is controlled by this company, the land being jointly owned by Henry M. Binder, Franklin G. Binder, and Clara G. Hartman, heirs of Wm. Binder, deceased.

The ore rights were leased in 1873 to Messrs. Fegley, Jones, Gabel, and Bertolet, of Pottstown.

Operations were commenced by them in that year, and a shaft sunk 62 feet without striking any ore.

No record of this shaft was kept, but the ground passed through was probably a mixture of Mesozoic shale and conglomerate, which covers the surface of the ground up to and beyond this shaft, so differing from the Phœnix slopes which all show limestone surface.

The services of the Diamond Drill Company of Pottsville were then secured before further sinking.

It is to be regretted that a faithful and continuous record of the core procured here was not kept, as it would have gone far to clear up the geological features of this whole series of deposits, the thickness of the different rocks, their position and character.

As it is, sections of this bore hole are to be found scattered all over the country, a few inches of the first boring in Mesozoic conglomerate being in the museum of the survey. All that can be positively relied upon in the record is the total depth reached—588 feet—21 feet of this being left as a water sump at bottom to catch the mine and surface drainage.

This record shows a covering of 376′ 7″ to have occurred before any ore was struck, and, strangely as the statement reads in the light of present developments, it is published below as an example of what errors can creep into an estimation of this kind.

RECORD OF BORING FOR MAGNETIC IRON ORE,

By the Pennsylvania Diamond Drill Company, of Pottsville, at Binder Shaft, Boyertown, Berks county, Penna.,

For Messrs. FEGLEY, JONES, GABEL & BERTOLET, *of Pottstown.*

		Ft.	*In.*
	Depth of the Mining Shaft before commencing to bore, . .	62	
1873.			
April 16 to May 5	Bored cored hole in red and white conglomerate rock, ...	125	3
May 6 to May 15	Bored cored hole in brown rock, (veined,)	137	1
May 16 to May 21	Bored cored hole in blue rock, (veined,)	52	3
	Total rock cover, ...	376	7
May 21 to May 23	Bored into Magnetic Iron Ore—1st ore bench, blue,	27	8
May 23 to May 26	Bored out hard black ore core—2d ore bench, black borings, No. 2, ...	25	5
May 26 to May 27	Bored out blue ore core—3d ore bench, blue borings, No. 2, ...	24	4
May 27 to May 28	Bored out hard black ore core—4th ore bench, black borings, No. 3, ...	26	6
May 29	Bored out blue ore core, 5th ore bench, blue borings, No. 4, 27 6		
" 30	do. soft (no core,) do. do. do. do. do. 5, 24 2		
" 31	do. do. do. do. do. do. do. do. 6, 22 3		
June 1	do. do. do. do. do. do. do. do. 7, 23 7	97	6
	Total Iron Ore, (no bed rock,)	211	5
	Total rock cover, ...	376	7
	Total depth, ...	588	

Combining the two first measurements under the head of Mesozoic conglomerates there would be a total of 187′ 3″ passed through. However, there is a south-east dip to these measures at shaft of at least 60°, and probably greater, which would reduce the real thickness of the conglomerate to about 94 feet, and every degree of inclination above 60° will reduce this thickness by about 3½ feet.

But even at this rate of reduction it is very hard to understand how 212′ feet of ore could be passed through unless it stood vertically; and as this is not borne out by mine development, I can only suppose that trap and dark colored impure limestone gangue were mistaken for ore by the man in charge of the boring. In point of fact, anywhere from a few inches to 40 feet of ore can be seen in the mine, but from 10 to 15 feet is a full average.

The brown and blue (veined) rock referred to in the section, is probably a species of chloritic diorite, containing a mixture of the basic feldspars, (Plagioclase) hornblende and epidote, familiarly called "greenstone" and which occurs in considerable quantity in the mine, as well as along the numerous railroad cuts south from Boyertown.

Occasionally radiating crystals of stilbite are seen in it, but rarely in the mine.

This "greenstone" is for the most part a crystalline mass, yellow to dark green when freshly broken, and weathering to a brown earth.

The blue coloring variously seen on some of this rock seems to be intimately disseminated through the whole mass, though more distinctly seen on the surface. No chemical determination of its properties was made however, and it is not of sufficiently frequent occurrence to demand attention, though probably occasioned by the development of copper salts. The output of the mine consists entirely of black magnetic ore, no blue ore, such as is found in the Gabel and Lower Phœnix mines, being as yet met with. This, however, will be sought for in the next lift underneath the black bed.

About 85 tons of ore are mined here on an average every day, the force required consisting (October, 1882,) of 38 miners, 1 blacksmith, 6 trammers, 1 laborer, 2 engineers, 2 firemen, 8 wharfers, 1 pump tender, and 2 landers; total, 61 men.

Jacob Schupp is boss at present, though up to October, 1882, William Clark was employed as night boss, from whom I received much valuable assistance.

The ore is all lump, and is loaded directly on to the company's cars from stock house on Colebrookdale R. R. siding.

All the ore goes to the Warwick Furnace, Pottstown, though its selling price is fixed at from \$4 to \$4.50 per ton.

The plant consists of a 30-horse power engine, 8″ cylinder, 18″ stroke, hardly adequate for the work it is called upon to perform.

There is also a pump located in lower level in shaft, which is kept constantly employed to keep mine dry.

The mine has three levels, with numerous gangways and counter gangways, many of which have been long since abandoned, and could not be explored. I, however, made several underground inspections of this interesting deposit, for an examination of which I had every facility willingly extended to me.

The elevation of the shaft above ocean datum is 381 feet. The first level is 420′ vertically below surface; the second level, 500′; the third level, 567′.

The second or 500′ level has proved one of the most lucrative and extensive, being fully 500 feet long, and trespassing over Gabel property line a considerable distance further.

It is colored gray on the Atlas mine map to this report. Some idea of the extent of the Warwick Trespass may be gained on inspecting this map—the immense excavation being tinted red. This point is 510′ below surface of Gabel shaft, and the lower (474′) level of that mine came into the stopes the Warwick Company had driven up, and at about 36 feet above the level of the Warwick middle level.

The ore body attained great thickness here, necessitating gangways on both foot and hanging walls, by which about 8,000 tons of excellent ore were removed by the Warwick Iron Co.

It will be noticed from the direction of the various gangways laid down on the mine map, that the ore has a general tendency to swing around Gabel hill towards the south.

Two gangways were driven on this (500′) level: one on the hanging wall, generally Mesozoic conglomerate, which is the most northern, ending south-east about under the Colebrookdale R. R. track; the second, or south drift, extends S. E., and then south into the Gabel property, and shows generally limestone for foot wall of same bed.

The average horizontal distance between gangways is about 50 feet, which would give a thickness of about 25 feet of ore measured at right angles to dip. But the space between these two gangways is by no means entirely occupied with ore, but frequently contains horses of serpentine limestone and greenstone, as well as many occurrences of

"pinching"—where the foot and hanging walls come together. Especially is this latter case true in the north gangway, where about 150 feet out from shaft the ore pinches to from 3″ to 1′; and again at end of gangway as shown on map, where the ore is entirely cut off.

The ore is found everywhere to lie in lenticular-shaped bodies, thinning out in the line of strike, and swelling into immense bunches in the center, variously mixed with limestone, with which it seems to be occasionaly intimately interstratified.

A fine illustration of this latter statement was furnished in the lower level of the Gabel mine, where in a piece of limestone 6 inches thick there were 4 bands of interstratified ore from ½ to 1 inch thick.

It was from this level, about 90 feet out from shaft, that a cross cut was driven about S. 40° W. in search of the blue ore bed found in the Gabel mine property.

It is probable that this bed does exist in the extreme south-west corner of the Warwick tract, but until struck at a much lower level than at present exists it would not pay to stope it, owing to the limited area it must occupy in the higher levels on this property.

The cross cut was not driven far enough to reach this bed for its limited development in the Gabel property shows it to have a decided tendency to bear to the north-west towards the Lower Phœnix slope.

The drift was closed at the time of my examination, but is said to have been carried first through 10 feet limestone, then 4 feet ore, and 143 feet through "quartzose sandstone."

Work was abandoned when within about 65 feet of property line.

The remainder of the 500′ level south gangway, from beneath railroad to the trespass, is driven through limestone and ore, the former being the general foot wall and dipping gently to the south-east about 35°.

A great deal of ore has been obtained from stopings carried up from this gangway along foot wall, as is shown on map.

Frequent masses of calcite, carrying clusters of pyrite, are seen in various places accompanying the ore.

When close to the property line with this level the north edge of an immense body of ore appeared, and in parting this drift to work it the ore was found to be fully 40 feet thick.

The "bonanza" was tempting, and the absence of connected surveys here led to a continuation of these drifts into the Gabel property with the before-mentioned results.

A magnificent pillar of excellent black ore, considerably crystallized, still remains as a support to the roof of this immense chamber.

Two small cross cuts have been driven to connect foot and hanging wall drifts—one in trespass entirely through ore, and the other under railroad.

An analysis has been made by the Pottstown Iron Company, E. K. Landis, chemist, June 22, 1881, of the limestone gangue accompanying the ore in the Warwick mine, the specimen being a black unctuous dirty rock, with the following result:

Silica,	13.80
Alumina,	1.10
Carbonate of lime,	81.16
Carbonate of magnesia,	4.20
	100.26

This agrees closely with similar gangue rock in the Gabel mine—see page 329.

An inspection of the lowest 567′ level in this mine, colored red on the map, will show that two general gangways have likewise been made here, connected in two places by cross cuts, and extending south-east close to the property line.

In the two parallel gangways driven *east* from shaft to meet ore body a considerable body of limestone was driven through as far as 125 feet from shaft, after which ore was gone through to Mesozoic conglomerate hanging wall, dipping here a little south of east 50° to 55°.

The last 60 feet of the most southern of these two drifts was entirely in ore, which here spreads out to a pinch N.

E. in about 30′ along main gangway, branching off from the north cross cut.

The quality of the ore here was excellent, but was soon cut off by the meeting of limestone and Trias measures.

To the south south-east along hanging wall gangway, the ore gradually thins away, until about 60 feet below south cross cut it varies from 3″ to 1′, though before swelling out much beyond the width of the gangway.

This "pinch" corresponds closely in position and character to that already mentioned as occurring in the 500′ level, the two gangways likewise being rather parallel.

The New Red hanging wall is here very soft with a soapstone face, coming almost in contact with limestone foot.

This "pinch" extends for 50 feet along gangway to point where the latter makes a decided turn towards S. 40° E., when another body of ore was met with 10′ thick and swelling into hanging wall, pinching again in about 35 feet.

This ore was stoped up for 40 feet, when it was found to extend back over pinch, thus showing a bulging and thinning on line of dip, as shown in Fig. 11, page 191.

This course is 120 feet long to a point under Colebrookdale R. R., where the gangway was turned south and shows a limestone top.

In 60 feet from here a greenstone dyke was met with, similar to that occurring in several places in this and in the 500′ level, in a line from this point to the shaft, never of any great thickness, and dipping rather to the north-east.

It is generally a true foot wall, no ore being found behind it, but in the 567′ level, in the hanging wall gangway, it partakes more of the character of a horse of rock, and is here only a few feet thick.

The foot wall gangway on this level is almost entirely in ore, often with a very steep dip, and in one place an overturned dip, the lowest level extending south-west of the middle level, both on foot wall of same bed.

This is well seen in small drift heading N. W. from main foot wall gangway, the drift being all in south-west dipping ore with an apparent hanging of sandstone.

It will be seen on the map that these lower gangways fol-

low the middle level openings around to the property line, the dips gradually flattening as we proceed southwards, until near the line they do not average over 35° and often fall to 20°, so that any stoping there would soon extend into the Gabel property once more.

Consequently most of the stoping in this mine has been confined to the middle level, where, on account of the sudden swelling of the ore into large bunches, all timbering had to be abandoned, and instead, immense pillars of ore left standing to support the superincumbent rocks.

One such pillar connecting the lower and middle levels, consisting of nearly ⅞ ore, is 30×40×80 feet high.

Some beautiful specimens of slickenslides were obtained in the mine where slips have occurred, notably along the New Red hanging wall face in the lower level, where a slip of 15′ was measured.

Some little development has been made in the top level, colored blue on the map, and while limited in extent, owing to the dip of the ore here soon carrying all stoping out of the property limits, they are for the most part abandoned also.

The same characteristics are seen there also—a Mesozoic conglomerate top and limestone bottom-wall.

It has been impossible to gain any definite information concerning the total output of this mine, but it must be in the neighborhood of 100,000 tons.

The average cost of mining per ton of iron ore is about $2 50, with a royalty of from 25 to 50 cents per ton additional, from which the value of this ore @ from $4 to $5 per ton can be readily computed.

Some idea of the composition and quality of this ore may be gained from the following suite of analyses kindly furnished by different consumers of the ore. I present first a complete analysis, No. 1, by A. S. McCreath, made from sample 163 pieces, dried at 212° F. :

	(1.)
Bisulphide of iron,	.806
Protoxide of iron,	18.000
Sesquioxide of iron,	41.463
Protoxide of manganese,	.018

Oxide of cobalt,	.010
Sulphide of copper,	.012
Alumina,	2.407
Lime,	12.980
Magnesia,	3.810
Sulphuric acid,	None.
Phosphoric acid,	.203
Carbonic acid,	6.930
Water,	1.285
Alkalies and undetermined,	.946
Silica,	11.130
	100.000
Metallic iron,	43.400
Metallic manganese,	.014
Metallic copper,	.008
Sulphur,	.434
Phosphorus,	.089
Phosphorus in 100 parts iron,	.205

The following are three additional analyses furnished by the Reading Iron Works:

	(2)	(3)	(4)	
Oxide of iron,	66.14	60.00	60.43	
Oxide of manganese,	trace	trace	——	
Alumina,	2.60	3.92	6.23	
Lime,	11.14	13.00	19.86	Carbonates.
Magnesia,	1.70	3.10	.91	Carbonates.
Silica,	8.00	11.30	10.36	
Phosphoric acid,	.22	not determined.	.07	
Carbonic acid,	3.60	5.70	——	
Iron pyrites, (FeS_2,)	7.08	2.13	1.44	
Water,	——	.90	1.16	
	100.48	100.05	100.46	
Metallic iron,	51.20	44.37	43.68	
Phosphorus,	.09	——	.04	
Sulphur,	3.78	1.14	.77	

No. 2, Leonard Peckitt, December 15, 1882, R. I. W. stock yard. Dried at 212° F.

No. 3, Leonard Peckitt, April 10, 1882, R. I. W. stock yard.

No. 4, W. D. Church, June 16, 1881, R. I. W. stock yard.

Partial Analyses furnished by Warwick and Pottstown Iron Companies, of Warwick Mine, Boyertown. Magnetic "Black Ore Bed."

	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Oxide of iron,	. .				69.30	72.60	64.78	62.62	54.10	57.55
Alumina,	10.0	8.0	4.0	3.5	15.10	2.60	3.80		1.68	trace
Lime,	14.0	10.5	11.26	8.44	8.30	13.90	18.20		41.425	11.90
Magnesia,	4.7	4.68	4.1	3.77	1.10	0.60	1.40	.		21.06
Silica,	15.5	15.5	12.25	11.75	5.40	10 00	9.70		10.75	10.70
Metallic iron,	35.00	39.20	50.00	46.50	50.20	51.73	46 90	45.34	39.18	41.66
Phosphorus,	0.113	—								
Sulphur,		2.3	. . .	.	0.29					

Warwick Company.

No. 5. E. F. Cook. Phos. by Booth and Garrett. Specimen after roasting.

No. 6. E. F. Cook. Phos. by Booth and Garrett. Specimen after roasting.

No. 7. E. F. Cook. Half roasted, half raw.

No. 8. E. F. Cook. Raw specimen. June, 1881.

Pottstown Company.

No. 9. W. D. Church, June, 1880. No. 10. Church, July 8, 1880. No. 11. September 11, 1880. No. 12. January 13, 1881.

No. 13 and 14. E. K. Landis, February 23, 1881, and July 5, 1881.

These various analyses will tend to show the variation of the ore from time to time, the percentage of metallic iron varying in these 14 analyses from 35 per cent. to 51.73 per cent., and averaging 44.883 per cent. In round numbers it is a 45 per cent. ore, carrying from .5 to 3.5 per cent. sulphur, and comparatively free from phosphorus.

Much that has been said concerning this ore and gangue is equally true of the Gabel Co.'s ore to the south-east, who mine the identical black ore of the Warwick mine, but who have in addition the underlying blue ore bed.

The following is a short sketch of the

Gabel Mine.

The land upon which this mine is located joins the Warwick Co. property on the south-west.

It is owned by Messrs. H. & J. Gabel and Griffith Jones, of Pottstown, who also operate the mine.

The original tract of land has been recently enlarged by the addition of 60 acres of the Samuel Shaner estate, comprising the Gabel hill immediately back of the mine as far south-east as the Engelsville road, as shown on map.

The mine has been worked since the spring of 1878.

The ore is magnetic, of two varieties, locally called "black ore," the same as worked in the Warwick mine, and "blue ore," similar in character to the "Rhoades vein" in the Lower Phœnix slope. Average production is 100 tons per month, employing when last visited (Oct., 1882,) 76 men.

Mr. Jones gives much personal attention to the mines, assisted by Mr. Willoughby Connor, to both of whom I am indebted for many courtesies.

The mining machinery and appliances at the mine are excellent, and are far in advance of any mine in the county.

These consist of one 140 horse power, with two 50 inch cylinders, 50 inch stroke, used for both hoisting and pumping, made by John West, Scott foundry, Reading.

The fly wheel is 12′ diameter, making 46 revolutions per minute. Winding drum 6′ diameter furnished with ½ inch steel rope, hoisting directly from shaft.

In addition to this, the engine house is supplied with a No. 1 Cameron pump for supplying water to boilers, drawn from Boyertown water works, 2 miles away.

Boilers are 22′ long, 5′ diameter, supplied with 14 six (6″) inch tubes. Heat enters at the bottom, circulates through the series of tubes, and exits at top and thence to stack.

One hundred and twenty-five (125) lifts of ore and water are made on an average per day, one lift comprising 1 ton of ore and 2 tons of water nearly.

Egg coal is used as fuel, costing $\$5\frac{10}{100}$ delivered at the

company's wharf. The shaft is furnished with self-acting safety cages (West, Reading), on which the mine wagons are loaded directly.

Ore is shipped from Colebrookdale R. R. siding, costing 8 cents for loading per ton on cars.

Pottstown Iron Co. and Reading Iron Works have been the principal consumers in the past, though a considerable amount of ore is now taken to the company's Norway furnace at Bechtelsville, which they have recently leased and repaired.

Sufficient water is obtained for all purposes at the mine, as all the ore mined is hard and requires no washing. 19 cages of water of 2 tons' weight are raised every 6 hours, equivalent to 560 gallons.

A vertical section through shaft—elevation at surface being 408′ above ocean level—shows:

180′ of banded and conglomerate New Red, the former occurring also as a layer of altered mud rock about 5 feet thick just on top of upper (black) bed. This bed in shaft occurs through 26′ of measures, mostly a calcareous breccia, faulted and broken, showing slickenslides, and rarely measuring over 5 feet thick.

Beneath this the shaft passed through 150′ of limestone, and then struck the blue ore bed probably 20 feet thick, but through which the shaft passed for 55 feet.

Beneath this 74 feet of chloritic rock, "greenstone" was met, 20 feet additional being driven as a water sump.

The mine has two levels, the upper (blue) 180′ below surface; the lower (red) 474′.

Some little development was carried on in the upper level close to the shaft, but the ore was greatly mixed with a light green limestone gangue, and so faulted as to decide further sinking. The underlying limestone is similar to that found in the Warwick mine, being mostly a serpentine green limestone of a light color, while the gangue rock limestone is much darker and often black from contained ore.

The following are two analyses of this rock by E. K. Landis, Pottstown Iron Co., June 22, '81.

No. 1 is from mass of limestone separating two beds of

ore. No. 2 is the gangue occurring with the ore itself, "black bed:"

	(1) White specimen.	(2) Dark green specimen.
Silica,	16.09	10.02
Alumina,	5.2	5.35
Corbonate of lime,	63.3	79.6
Carbonate of magnesia,	18.3	5.79

Whilst mining in the upper level the Gabel company became convinced of the trespass that had been made on their property through the 500′ level in the Warwick shaft, and decided to test the matter by driving out.

The two ore beds and intervening limestone all dip conformably in the shaft at about 45° S. 55° E.

Before sinking, however, through the greenstone foot wall of the blue bed, which is exceedingly tough and hard, a winze was put down on foot wall of blue bed for 76′ on slope, when it was found that the ore dipped much steeper, consequently lessening the distance necessary to be gone through to meet the trespass.

From the 474′ level the main gangway was started S. E., and owing to the increased inclination of the measures the blue bed was struck in 30 feet instead of 64.

The gangway was continued on same course through 33 feet of blue ore bed, here dipping about 60°.

At this point the course of the gangway was changed to about S. 75° E., in order to get at trespass supposed to be 200 feet away from this point.

The remaining part of the gangway was entirely in limestone, also showing an increased dip, though flattening again to the south-east.

At 175′, ore (black bench) was struck, the ore body having greatly swelled here into foot wall, and presenting one of the finest deposits to be found in the mine.

The gangway came into the stopes of the Warwick Company, driven up from their 500′ level, on a dip here of about 35° to the S. E.

The ore beds in this mine are like those in the other shafts. They occur in masses and bunches 40′ thick and again pinch out to a mere leader, and are by no means, therefore, con-

tinuous bodies of ore. The ores, however, show one difference in that they are harder and more compact than in the other mines, an instance probably due to their proximity to the Gabel Hill dyke, which may have exerted some influence in altering their physical properties.

Two gangways have been driven in the foot wall of the black ore bed, as shown on map, owing to its great thickness here and large limestone partings.

Stoping has been carried up almost into the shaft, 180′ feet below surface, proving the identity of the faulted bed there found with the magnificent body of ore in the lower level.

The Warwick gangways (grey) have likewise been extended along hanging wall (New Red) but not from the 500′ level, being started from the stopings that company had made.

These drifts along hanging wall, as well as those on foot wall, have been carried out considerably further to the south than shown on the map, two of them being at least as far out as the barn on private lane south-east of shaft.

They well illustrate the tendency of the ore body to swing around hill.

Some stoping has also been done on the blue ore bed as shown on map; but the inferior quality of this ore delays extended development.

The company intend sinking another lift in the near future, from which they will drive S. E. along the line AB, thus opening (though at considerable expense) a third level on this valuable ore tract.*

This mine is excellently conducted in its underground workings, and presents a good field for the study of this deposit.

The company drove a cross cut from second level southwest into hill with the purpose of proving their ore ground, but soon found the ore to be cut off by the diorite dyke in Gabel hill.

It only remains to present a few analyses of these ores collected from various sources, which show well their char-

* This work is now progressing, June, 1883.

acter and offer a partial means of comparison with those found in adjoining properties.

The first (No. 1) is a complete analysis of the blue ore bed by Mr. A. S. McCreath, sampled by him at the same time as the Lower Phœnix and Warwick mines, from 20 lbs. of the ore, dried at 212° F. :

(1.) Gabel Blue Ore.

Bisulphide of iron,	2.728
Protoxide of iron,	13.757
Sesquioxide of iron,	31.465
Protoxide of manganese,	.389
Oxide of cobalt,	.020
Sulphide of copper,	.227
Alumina,	4.119
Lime,	10.450
Magnesia,	7.982
Sulphuric acid,	.050
Phosphoric acid,	.084
Carbonic acid,	.645
Water,	1.390
Alkalies and undetermined,	4.364
Silica,	22.330
	100.000
Metallic iron,	34.000
Metallic manganese,	.302
Metallic copper,	.151
Sulphur,	1.551
Phosphorus,	.037
Phosphorus in 100 parts iron,	.109

Two more partial analyses of this same ore (Nos. 2 and 3) are next presented, furnished by Pottstown Iron Co., chemist, E. K. Landis, November 26, 1881, and February 25 1882:

	(2)	(3)
Oxide of iron, (Fe_3O_4,)	53.48	42.51
Alumina, (Al_2O_3,)	1.97	7.34
Lime, (CaO,)	6.55	9.55
Magnesia, (MgO,)	5.85	5.26
Silica, (SiO ,)	22.86	28.95
Metallic iron,	38.72	29.76

The following are analyses of black ore bed, same mine:

	(4)	(5)	(6)
Oxide of iron,	62.48	58.76	68.06
Alumina,	12.35	3.19	4.77
Lime carbonate,	12.94	19.44	11.75
Magnesia carbonate,	5.58	4.25	5.33
Silica,	8.20	11.55	10.65
Metallic iron,	45.20	42.54	47.10

They are all from the Pottstown Iron Co.'s books, and are analyses by E. K. Landis, chemist.

No. 4, July 21, 1881. No. 5, November 2, 1881. No. 6, April 19, 1882.

They show the varying character of the ore, as well as its resemblance to the Warwick mine deposit.

The next analysis, No. 7, has been recently made by Mr. Leonard Peckitt, of the Reading Iron Works, ore dried at 212° F.

No. 8 is a complete analysis by McCreath from sample taken at same time as Warwick ore, with which it may be readily compared.

No. 7.—Peckitt.

Oxide of iron, (Fe_3O_4,)	66.14
Oxide of manganese,	trace.
Alumina,	2.60
Lime,	11.14
Magnesia,	1.70
Silica,	8.00
Phosphoric acid,	.22
Carbonic acid,	3.60
Iron pyrites,	7.08
	100.48
Metallic iron,	51.20
Phosphorus,	.09
Sulphur,	3.78

No. 8.—McCreath.

Sampled by Mr. J. H. Harden.

Bisulphide of iron,	4.740
Protoxide of iron,	21.407
Sesquioxide of iron,	47.447
Protoxide of manganese,	.669
Protoxide of cobalt,	.240
Sulphide of copper,	.347
Alumina,	2.440
Lime,	8.120
Magnesia,	2.583
Sulphuric acid,	.125
Phosphoric acid,	.208
Carbonic acid,	.500
Water,	.690
Alkalies, (by difference,)	3.034
Silica,	7.450
Total,	100.000

Metallic iron,	52.075
Metallic manganese,	.519
Metallic copper,	.231
Sulphur,	2.694
Phosphorus,	.091
Phosphorus in 100 parts iron,	.174

Some further explorations for iron ore have been made in this region, but have all proved failures, owing mostly to the bad location of the workings.

About 300 yards S. W. from the Gabel shaft, and about 30 feet up hill from railroad on south side of small ravine, there is an abandoned horse and windlass shaft, originally opened by Messrs. Rhoades and Grim, of Boyertown, who claim to have found ore there.

The rock on dump is a greatly decomposed close-grained grey diorite, showing crystals of albite feldspar. I should say the opening was made too high in hill to discover any body of ore, the same mistake having been made in the more recent opening made on Major Wren's place, about a mile further S. W. in same hill, where a shaft and tunnel have both been driven unsuccessfully into hornblendic diorite rock.

Some strong indications of the presence of magnetic iron ore are next met with south of Earlville in Amity township, in the neighborhood of High's mill, where there is a large development of the Mesozoic conglomerate.

No tests, however, have been made there to my knowledge, though there is a great deal of magnetic attraction.

Fritz Island Mine.

The next important mine on this range occurs on Fritz Island, in the Schuylkill river.

Though the surface of this island is covered with river drift, concealing its true rock formation, but little doubt exists in my mind that its geological position is in all respects identical with that existing at Boyertown.

The same conglomerate and trap exist there, though slightly changed in character, the former being much more calcareous, and the latter showing a larger percentage of basic soda-lime feldspars, and hornblende, a true horn-

blendic diorite, though closely resembling a syenite, being distinctly stratified and rather free from quartz grains.

The rock is a portion of the Flying Hill dyke, which turning sharply to the west on Poplar Neck passes through this mine and into Cumru and Spring townships.

Island Mine.

This mine is located about 2 miles south of the P. & R. R. R. depot at Reading, on an island owned by Martin Fritz.

This island is formed by Mifflin's arm extending around its western side, and is about ¾ miles long.

Its greatest breadth is about 300 yards, tapering at both ends north and south, as will be seen on inspecting map of this locality in Atlas to this report.

Between it and the eastern main land, and just east of its north end, there is another smaller island—Yost's Island—owned by the Reading Iron Works, under which the lower workings of Slope No. 1 extend.

Agriculturally, the soil of these two islands is very rich, as is evidenced by the fine grain crops raised there through many successive years. Though partially covered with river drift, the whole of Yost Island and the northern part of Fritz Island is probably occupied by the Mesozoic conglomerate, so calcareous as to account for the rich soil on these two properties.

The southern half or three quarters of Fritz Island shows many decomposed boulders of diorite trap containing hornblende and feldspar, and, though no appearance of a dyke in place is seen, it probably exists at no great depth, together with indurated red shale and sandstone.

For reasons already stated it is difficult to determine the boundaries of the rock formations on this island, but it is hardly probable that the conglomerate occupies a space of more than 400 yards in width and this is confined to the north end of the island. It nowhere outcrops, so that its surface character can only be judged from its appearance as brought out of the mines.

This shows it to be very calcareous, consisting of masses

of calcite of all sizes, some of these masses weighing 5 or 6 pounds, somewhat worn, and cemented in a greenish white paste, the whole being much softer and more brecciated than the conglomerates on the east side of the river near the Big dam. They are true pudding stones and are very firm and compact and of rather a reddish color.

The color of all the gangue on the mine dump is a dull sea-green ; the rock has a soapy unctuous surface, and contains a good deal of serpentine.

Mining is confined to a few acres, and in addition to the large yield of iron ore, the locality has been a famous one for the mineralogist, yielding in the past specimens of magnetite, hematite, malachite, azurite, brucite, chalcopyrite, bornite, galenite, calcite, serpentine, retinalite, soapstone, garnets, chabazite, thomsonite, apophylite, undescribed zeolite. mesolite, stilbite, and prochlorite, a detailed list of which will be found in table of Berks county minerals, chapter XII, of this report.

Much of the information obtained concerning this mine was courteously furnished by Mr. Horatio Trexler of the Reading Iron Works, and Dr. D. B. Brunner of Reading, supplemented by two personal visits, in one of which, under the guidance of Henry Taylor, Supt., a thorough inspection of the underground workings was made.

There are two slopes, both of which are shown on the map, about 300 feet apart, by means of which this ore body is worked.

No. 2, the most western, was idle at time of visit, and, though several underground gangways exist there, no map has ever been made of them, the present map having been made by Messrs. Kendall of Reading, from which I was kindly allowed to make a tracing.

It is to be regretted that the management does not see fit to order a complete map of this interesting mine, for, owing to its peculiar geological features, no mine in the county more urgently demands such a map—kept up to date—in order to intelligently study the character of the deposit.

The reason for this will be seen in the following pages.

At present the mine is held in equal parts, under a lease

dated 1846, by the Reading Iron Works and Eckert & Bro.; the management of the mine is under the control of the Reading Iron Works.

But little definite information could be obtained concerning the early workings of this property, no one approached seeming to have any distinct recollection of the same.

Dr. Brunner, in his article in the Reading "Herald," January 3, 1882, apparently fixes the date of first mining as 1850–51, for he says that "during the high water of 1850 and 1851, some ground was washed away where the principal slope is now, and uncovered a vein of ore. Mr. Martin Fritz, the owner of that portion of the island, dug up a small quantity with a pick and shovel.

"The fact was made known to iron manufacturers, and a lease was obtained by Messrs. Eckert, Schwartz, McManus & Co. Horse power was first employed to raise the ore, which was deposited on three equal heaps, one for each of the parties.

"Mr. John Schwartz, not being able to use the ore in the Mt. Penn Furnace, which was a charcoal furnace at that time, sold his interest to the other parties. The ore was near the surface, and the vein thick, so that in the fall of 1851 about 3,000 tons were taken out."

Mr. Trexler states that the mine has been in operation for 40 years, and adds that the ore was first used at Mount Penn Furnace.

At all events mining was carried on sometime within the decade of 1840–50, and ore was first obtained in the open cut south of No. 2 slope, shown on map, to a depth of 35 or 40 feet.

Though there are many points of similarity between the Island mine ore and that of the other mines situated along the edge of the Mesozoic conglomerate, there are at the same time some striking peculiarities in this deposit.

In common with the other mines of the series, the ore occurs underneath the Mesozoic conglomerate, having it generally for a hanging wall, calcareous and brecciated. Trap (diorite) rock is occasionally foot wall, but more fre-

quently a decomposed sandstone (Potsdam ?) is the floor. Especially is this the case in No. 2 Slope.

The ore itself occurs in a magnesian limestone or dolomite, which often forms "horses" or wedges of rock, upon each side of which the ore occurs in lenticular-shaped bodies from 18″ to 22′ thick.

The ore, as at Boyertown, often pinches out to nothing when foot and hanging wall come together, and again bulges out into immense chambers, yielding thousands of tons of excellent ore.

From this condition of things, comparatively little timbering is done in the mine, large pillars of ore being left to sustain the overlying rock. Its origin is probably identical with that at Boyertown.

The peculiarities of the deposit are shown in the almost due east and west strike of the ore, owing to the sudden change in bearing of the conglomerate at the base of Neversink hills, and is so unlike the persistent N. E. and S. W. course of the series of rock formations and included ores of the county.

A more striking peculiarity, however, is the north dipping ore in the No. 1 slope, almost a unique occurrence throughout the numerous magnetic ore deposits in the county.

It is probably caused by the trap dyke found in the lower levels, after cutting through which south dipping ore was found.

No. 1 slope has been carried down on outcrop for 231′ on slope starting with a 62° dip, but averaging about 46°. Three levels have been started east from slope, as shown on map, passing under the bed of the Schuylkill and about 100 feet on to Yost's Island, though these gangways are probably more extensive than shown on the map.

The gangways are vertically about 60′ apart, the upper (blue) level being about 50 feet below surface of ground.

Ore has likewise been found on east bank of river near tow-path, on High's property, in direct extension with these gangways, though mining was stopped when out 450′ from bottom of slope, owing to the difficulties of ventila-

tion. The same trouble is experienced in the eastern gangways of the Island mine, and it seems strange that another shaft has not been put down on Yost's Island to relieve this want.

Preparatory to any such movement the present map should be brought up to date and the workings on the High property located, as much money can be saved if the new shaft is advantageously located.

An inspection of these gangways will show the character of the deposit. Considerable stoping has been done from the lower (black) level up to the two overlying ones. In the lower drift—when out 125′ from slope—the ore branched and was followed around in two gangways with a horse of limestone between, meeting when out 300 feet from shaft.

The middle (red) level ore shows an increasing dip going eastward, until at 300′ from slope it is vertical and has been so stoped out up to the upper (blue) level.

To the west of slope ore has been mined in the two lower gangways for from 50 to 100 feet out from slope, showing considerable irregularity in the deposit here, which is represented by the course of the gangways, as laid down on the map.

All of these drifts met with trap, and it was finally decided to cut through the dyke and prove property on the other side.

The lower level was carried through by a drift almost due south, 50 feet long and at right angles to the strike of the rock.

The dyke was found to be nearly vertical and about 80 feet thick, 30 feet having been passed through in the preceding course. A sample selected at end of this drift has been analysed by Mr. Leonard Peckitt, chemist for the Reading Iron Works, who reports the following results, showing it to be a basic igneous rock:

SiO_2,	=53.00
Al_2O_3,	=18.90
Fe_2O_3,	= 8.57
CaO,	=12.50
MgO,	= 6.90
Metallic iron,	= 6.00

It also contains titanium, phosphorus, and manganese, which were not determined quantitatively.

As far as can be compared with the partial analysis, the rock shows quite a similar composition to that mentioned by Dr. Frazer in Report C, p. 122, a dolerite from Beeler's farm, two miles S. W. of York, York county, Pa., a full analysis of which has been made by Dr. F. A. Genth, and is inserted here for comparison :

Silicic acid,	52.53
Phosphoric acid,	0.15
Titanic acid,	0.32
Alumina,	14.35
Ferric oxide,	5.93
Ferrous oxide,	5.45
Manganous oxide,	Trace.
Magnesia,	7.99
Lime,	10.27
Lithia,	Faintest trace.
Soda,	1.87
Potash,	0.92
Copper,	Trace.
Sulphur,	0.08
Ignition,	1.23
Total,	101.04

Immediately after reaching the south side of this dyke a small leader of magnetic iron was struck, dipping *south* now, and apparently the same ore that is mined on the 45° slope of No. 2.

Here again an accurate mine map showing position of levels in No. 2 would be of great service in identifying this bed with that already explored, no practical test being at hand, as this gangway in No. 1 slope is 100 feet vertically below the lowest workings in No. 2.

This ore has been analyzed by Mr. Peckitt, July 29, 1882, with the following result :

Metallic iron,	54.00
Metallic copper,	.25
Sulphur,	3.40
Silica,	7.30

After roasting this would show an excellent quality of ore, though it can hardly be expected to run as good.

However, no definite reason is given for not pursuing mining more actively in this slope, for another analysis of Mr. Peckitt's made for iron and silica showed Fe = 54.14, SiO_2 = 10.85.

The slope is already down 142′ on a dip of from 40°–55°, probably averaging 45° so that another 100-foot lift would open up a fine territory of ore through a series of excellently ventilated gangways.

The levels are comparatively clear also. The ore outcrops in open cut to south of engine house, the slope being put down in rock.

Several analyses have been made of the ore now mined at No. 1 slope, of which the first is by Mr. Leonard Peckitt, R. I. W., August 21, 1882, sampled at mine, and which Mr. Peckitt considers fairly representative of the yield :

(*1.*)

Protoxide of iron,	17.90
Sesquioxide of iron,	41.32
Iron pyrites,	.37
Copper pyrites,	.99
Sesquioxide of manganese,	.67
Alumina,	2.00
Lime,	9.41
Magnesia,	2.45
Sulphuric acid,	None.
Phosphoric acid,	.04
Carbonic acid,	10.10
Water,	.85
Silica,	14.02
Total,	100.12
Metallic iron,	43.00
Metallic copper,	.590
Sulphur,	.529
Phosphorus,	.019

Lime and magnesia exist as carbonates. Iron and copper pyrite are present as a double sulphide of iron and copper (Cu_2S, Fe_2S_3.)

A comparison of this analysis with that from No. 2 slope by Mr. Peckitt will show a difference of 11% metallic iron in favor of the former, while at the same time the No. 1 slope ore contains .34% more copper and 2.87% less sulphur.

Another marked difference in silica will be noticed—14.02% in No. 1 as against 7.30% in No. 2.

These differences are the harder to understand as the body of ore is apparently the same, but if they should be in force throughout the deposit, a larger development of No. 2 slope would seem desirable in spite of the great increase in sulphur.

Another analysis (No. 2) of this Island mine ore, Slope No. 1, was made by Mr. A. S. McCreath, from sample of 25 lbs. of the ore dried at 212°F., with the following results :

(2.)

Metallic iron,	38.050
Metallic manganese,	.417
Metallic copper,	.558
Alumina,	1.893
Lime,	7.790
Magnesia,	10.090
Sulphur,	1.141
Phosphorus,	.038
Silica,	16.130
Phosphorus in 100 parts iron,	.099

The average daily production of this mine is from 25 to 30 tons at present, or about 10,000 tons a year.

Since its opening it has twice been idle, once in 1857 and again from 1873 to 1879, but I don't think it would be any exaggeration to put its total yield at 250,000 tons.

At present there are about 32 men employed there under Henry Taylor, supt.,—22 miners, 4 engineers, 1 carpenter, 1 blacksmith, and 4 outside laborers.

One 20 horse-power engine is used entirely for pumping, and one 15 horse-power engine for both pumping and hoisting.

These are both located on surface, with two (2) donkey engines for emergencies, as the mine is apt to be seriously troubled with water inside and out.

To protect themselves from the Schuylkill overflow—the surface of the mine being only four to six feet above water level in the river—the company some years ago threw up a guard bank, shown on map, all around the surface plant, which effectually secures them from all dangers of an ordinary spring freshet.

Like most of the mines in Berks county the slope is badly situated, and the arrangements for pumping water and raising ore very awkward and primitive.

The ore is shipped by canal boat from wharf at mine in equal parts to Messrs. Eckert & Bro., of the Henry Clay furnaces, and the Reading Iron Co., costing 36 cents per ton. The cost of mining is about $2.

The ore is magnetic and quite similar to the Wheatfield mine ore further west on this range, but has, perhaps, less iron pyrites, or rather this latter ingredient is not so generally disseminated through the body of the ore.

Its location in proximity to the various blast furnaces of the Schuylkill Valley will always secure to this ore a ready sale, and with a comparatively small outlay of money its daily production can be readily increased to meet any extraordinary demand.

Before passing to the next important development of this ore—the Wheatfield mines in Spring township—it may be well to add a few words on an intermediate deposit long since abandoned, but which appears to have yielded a large quantity of ore in the past. This is the

Raudenbush mine,

situated about ½ mile west of the Island mine, in Cumru township, at the base of the trap hill shown on Index map. At present the mine is fallen shut, but shows a slope going down S. 30° E. 40°.

There are also two small shafts on the property, one of them about 50 feet deep.

On the dump are seen grey, greenish, and black limestone, very much decomposed, some of which may represent the presence of the brecciated Mesozoic "all sorts," so characteristic of this part of the range; but none such is seen in place on the surface.

Numerous trap boulders lie on surface mixed with mine gangue, likewise greatly disintegrated.

The green coloring seems to pervade the whole mass of the rock, though more marked on the surface, no doubt

due to the decomposition of the contained sulphurets of iron and copper.

Most of the limestone seems altered, accounted for by the proximity of the trap dyke to the south.

This trap shows in the 50-foot shaft, as also some light grey to white limestone, the latter showing also a slight coating of hematite.

Very little could be learned about this mine, owing to its idleness for a number of years, but it was evidently actively worked during the time of the First Survey, for Rogers refers to it on page 717, Vol. II, of his Final Report, as yielding about 5000 tons a year to its proprietors, the Phœnix Iron Company.

He further states, concerning operations here, that "The vein ranges a little N. of E. Its foot wall is a white metamorphic limestone or marble, and its hanging wall or roof a dull sea-green serpentine-like rock, which on exposure soon crumbles down like ordinary shale.

"The vein dipping 36° S. is followed by a slope 280 feet beneath the surface. At the bottom gangways are driven 200 feet west and 400 feet east to a fault cutting out the vein. A higher level 160 from the surface is driven 300 feet east.

"Like all others, this vein is exceedingly variable ; while wholly or almost entirely absent in places, in others it has been found 30 feet thick. Its average bulk will not exceed 12 feet.

"The gangue stone of the ore is a light-blue rotten limestone, from which the ore is scarcely distinguishable except by its greater weight and deeper tint."

No trace of the conglomerate is met with until the headwaters of the Cacoosing creek are reached in Spring township, about 5 miles west of the Raudenbush mine, where they once more appear and occupy a narrow belt 1 mile long, in which are located several ore openings. The most important of these is

The Wheatfield Mine,

located about 2 miles south of Sinking Spring and 1 mile E. S. E. of Fritztown.

The name was derived from the first discovery of the ore, about 1851, in William Fisher's wheat-field.

The whole farm was purchased shortly afterwards by Messrs. Eckert, Clymer, Reed, Schwartz, and McManus, who at once erected machinery necessary to take out a large quantity of ore.

When first visited, July 26, 1882, the mine was being "cleaned up" and very little ore was being taken out, and shortly afterwards work was entirely suspended.

In July the product—about 25 tons a day—was being divided amongst the present lessees, Messrs. Eckert, Brooke, Clymer, and Trexler.

The superintendents, Messrs. Robt. Pickings and John Johnson, had a force of 35 men employed, only 8 of whom were miners.

The Henry Clay furnaces were getting most of the ore then. One 15 and one 12-horse power engine were used for hoisting, and 3 (Allen, Tamaqua,) steam pumps for pumping water.

A map of the various openings here is shown on page 345, Fig. 16, constructed by Mr. O. E. Heinrich, 1879, who also made a report to the company at that time.

While the geological position of this mine is identical with the others of this range its individual peculiarities are strongly marked and show a very confused and irregular structure.

The surface rock is all Mesozoic conglomerate, here a dense brecciated limestone of a gray-white color, rarely containing any red or pink colored limestone like those further east and made up of angular fragments of limestone from the size of a pea to a man's fist. Occasionally chunks of dark-green serpentine occur, giving the rock a checkered appearance.

It is capable of a high degree of polish and would make beautiful table slabs if it could be obtained in pieces of sufficient size.

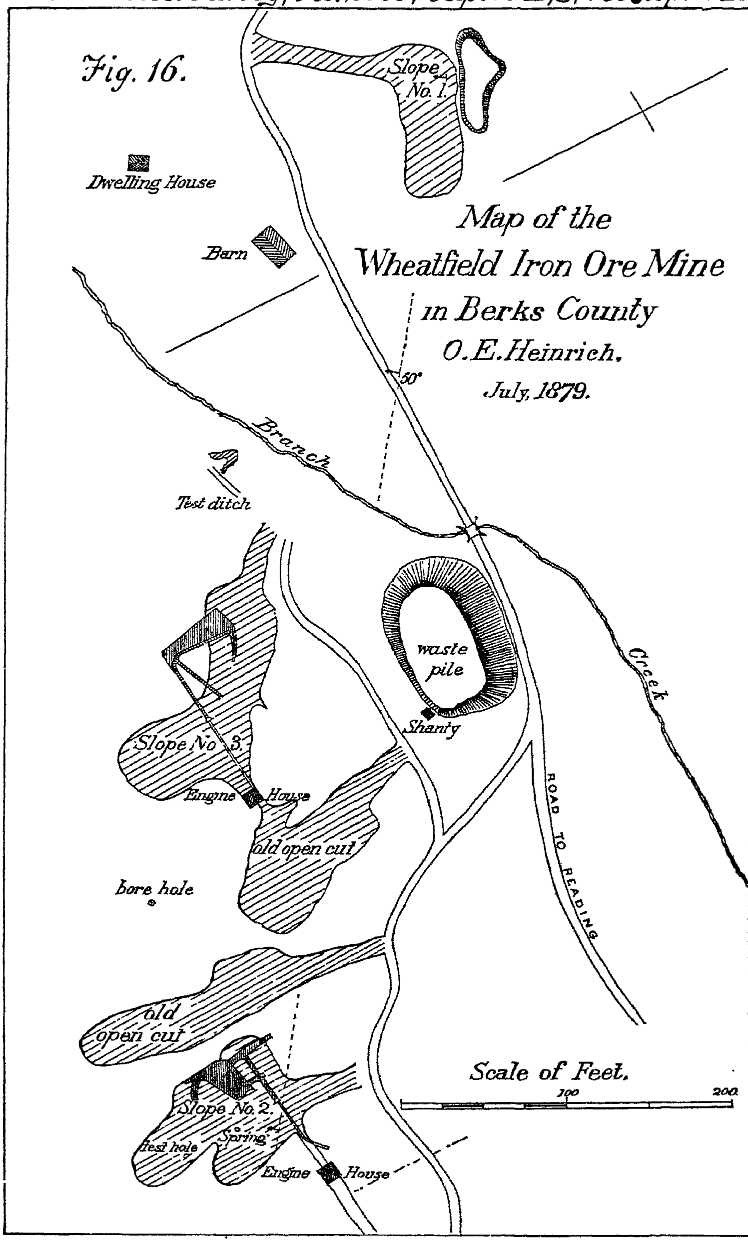


Fig. 16.
Map of the
Wheatfield Iron Ore Mine
in Berks County
O.E. Heinrich.
July, 1879.
Slope No. 1.
Dwelling House
Barn
50°
Branch
Test ditch
waste pile
Shanty
Creek
Slope No 3.
Engine House
old open cut
ROAD TO READING
bore hole
old open cut
Scale of Feet.
100
200
Slope No. 2.
Spring
Test hole
Engine House

This rock forms the hanging wall or roof of the ore, though, occasionally, I am informed, true red shale is met with in that position.

The gangue rock appears to be limestone wherever met with as horses or wedges that divide or cut into the ore or foot-wall trap.

The latter rock occurs as numerous small dykes of greater or less persistency, shooting out from the red shale country to the south with a general N. W. and S. E. course, dipping to the *south-west* at angles of from 35° to 50°.

No ore has been found to the north of them. The ore body apparently lies in pockets in limestone on the south-west side, pinching out to nothing and swelling in thick masses into the hanging wall.

These deposits have no very great extent along line of bearing, but rather occur *en échelon*, but *always* on the south side the trap.

The unusual strike of the beds will be at once remarked, being turned around 90° from the customary N. E. and S. W. trend of the rocks.

The ore, on the other hand, appears to strike about N. 10–15 E., and dip to the N. W. 30° or 35°, the trap in every case cutting off the extension of the ore to the N. E., though only as regards each individual deposit.

The ore occurs in lenticular-shaped bunches from 3′ to 20′ thick, the top ore being black in color, and softer than ore found in the bottom levels. This latter is of a distinct blue cast and very hard, requiring blasting to remove. Several acres of ground have been explored in search for ore, and a glance at the page-plate map will show the complicated nature of the deposit.

Surface workings were first carried on in the soft ore to the depth of 30 or 40 feet, after which a system of underground mining was pursued to gain the harder ore.

The most eastern workings are at Slope No. 2, driven down on outcrop 140–150 feet, on a slope 45°, nearly due west. Gangways have, as usual, been driven north and south. The approximate position of the trap dyke is shown by a dotted line, as well as its south-west dip.

The ore runs along the south face of this, spreading southwest into hanging wall of brecciated limestone. Indications of the continuation of this dyke N. W. into the two old open cuts, and even on to the public road, may be observed, dipping at the latter place about S. 40° W. 50°, but very narrow.

About 200 feet S. W. of this another parallel trap dyke cuts through the workings at Slope No. 3, here down 270 feet on a 35° dip, and has been uncovered 17′ below surface, near dwelling house shown on map, showing the same characteristics as the first-mentioned dyke.

Mr. Heinrich, in his report, calls this an "amphibole rock,"* referable to the Laurentian series, and encloses the ore in a synclinal fold, of which the two dykes already mentioned form the north and south limbs. He also makes the prominent trap ridge to the north of the public road, Laurentian, whereas no Laurentian rocks appear until the eastern flank of Millbaugh hill is reached—a mile, at least, further west.

Indications of ore are also reported in test ditch shown on map, Fig. 16, about 400′ N. W. of engine house at No. 3 Slope.

On north side of public road, at workings called Slope No. 1 on map, ore has also been mined.

The ore body seems very much more regular at this latter place, having a distinctly east and west strike, almost at right angles to the deposit south of the ravine separating Slopes Nos. 1 and 3. See map, page 349.

This opening marks the most northern limit of the brecciated limestone. The slope goes down on ore dipping 40° to the S. E., underlaid by trap and overlaid with Mesozoic conglomerate.

These workings are also abandoned, but were carried down nearly 100′ on slope, with gangways east and west. The ore body is from 2 to 12 feet thick. There is about 1,500 tons of ore lying on dump here yet, which shows a good deal of lime and sulphur.

* While being mostly composed of hornblende and rather deficient in feldspar, this rock is still a close-grained, compact diorite.

The ore from these various openings was hauled by private teams to the company's wharf on the Reading and Columbia R. R. at 40 cents per ton.

It is impossible to give any but an approximate idea of the yield of these mines, but having been worked almost continuously from 1851, fully 300,000 tons of ore must have been removed.

The ore contains a considerable amount of sulphur disseminated through it, though there is a tendency for the iron pyrites to form in small veins.

The analyses appended will show, likewise, the unusually large percentage of magnesia (MgO) contained in this Wheatfield deposit, and it may also be stated in this connection that the percentage has increased from Boyertown westward in all the ores of the range.

The mine on north side of road is considered to be pretty well played out. It had been idle for a considerable time prior to 1879, but in that year during the "boom" a large force of men was put on there and a good deal of ore raised. The mine was soon condemned, however, and the machinery removed.

The Wheatfield mines have also been quite a favorite locality for minerals, though as most of the débris and gangue rock is now left in the mine to fill up old chambers, very few specimens can be obtained at present.

Yellow, green, and black serpentine, retinalite, calcites, fluorites, prochlorite, stilbite, amethystine-quartz, and a few pieces of native copper, are said to have been found there and at the Ruth mine quarry further west.

The following are some analyses of this ore:

	1.	2.	3.
Oxide of iron (Fe_3O_4,)	50.07	——	——
Oxide of manganese (MnO,)	.31	——	——
Alumina,	2 35	1.398	3.60
Lime,	2.60	2.750	3.57
Magnesia,	13.10	13.848	13.34
Silica,	20.01	17.960	19.60
Iron pyrites,	1.59	——	
Water,	.60	——	
Phosphoric acid,	.07	——	
Carbonic acid, etc., (by difference,)	9.30	——	
Phosphorus in 100 parts iron,	——	.048	——

Metallic iron,	37.00	41.025	37.80
Metallic manganese,	——	.137	——
Metallic copper,	——	.005	——
Sulphur,	0.85	1.203	0.91
Phosphorus,	0.03	.020	0.02

No. 1, Leonard Peckitt, sampled at R. I. W. stock yard, August 12, 1882.

No. 2, A. S. McCreath, sampled at wharf, 20 lbs., @ 212° F.

No. 3, Austin Farrell, St. Louis, Mo., (furnished by E. & G. Brooke Iron Co.,) March 1, 1883.

Mr. Peckitt has recently sent me another determination of this ore dried at 212° F., of which the following are the results:

		4
Protoxide of iron,	37.05	52.47
Peroxide of iron,	15.42	
Oxide of manganese,		.30
Alumina,		5.90
Lime,		1.90
Magnesia,		11.38
Silica,		20.20
Iron pyrites,		3.58
Copper pyrites,		.15
Water,		1.25
Phosphoric acid,		.15
Carbonic acid, etc.,		2.50
Total,		99.78
Metallic iron,		39.60
Metallic manganese,		.23
Metallic copper,		.12
Sulphur,		1.94
Phosphorus,		.06

Mr. Peckitt also sends an additional partial analysis to show MgO, as follows, (February 8, 1882:)

Metallic iron,	27.40
Silica,	22.32
Magnesia (MgO,)	19.18

Higher up hill, and about 400′ E. S. E. of Slope 2 of the Wheatfield mines, there is another opening known as the *Reber shaft* or *Raub mine*.

Everything was idle there on July 26, 1882, and but little iron ore on dump. The surroundings were similar to these on Wheatfield property.

West of No. 2 slope, and about 3,000 feet down valley close to the public road leading south from Fritztown, is the old

Ruth Mine,

situated on property of Henry Ruth and about 800 feet north of J. Dalton's house.

Ore has been extensively mined here, and, after a rather checkered history, it has been recently condemned as played out and abandoned.

Its geological horizon is similar to the Wheatfield mines, and is apparently on same bed as that worked on No. 1 slope.

Ore was discovered here about 1847, or 4 years prior to the Wheatfield discovery, and the property was thoroughly tested by sinking a number of 20-foot shafts.

When the body of the ore was located active operations were commenced by the erection of an engine house and machinery for raising ore and pumping.

The mine was operated with some few interruptions till 1863, during which period Mr. Daniel Ruth reports about 10,000 tons of excellent ore to have been mined.

Some further prospecting was done in 1878, but was confined principally to the surface, no effort being made to pump out the old workings, and confirm or deny the assertion that the ore had played out.

Finally, two-thirds interest in the property passed into the hands of J. S. Livingood, Esq., of Reading, the remaining one third being retained by Daniel and Aaron Ruth.

When visited in July, 1882, the property had been leased to the Monocacy Iron Co. and Daniel Fisher, of Harrisburg, who had commenced work on June 19, 1882.

A new engine house has been erected and supplied with a 15-horse power engine, but no ore has been raised, owing to the great amount of water that had to be pumped.

Strangely enough, the lessees went to the great and rather unwarrantable expense of sinking a shaft here south of the old slope head, and at such a distance that, all said and

done, they could only hope to strike the bottom of the existing slope. The slope from which all the ore had been mined has a dip of 35°, down 190′ on foot wall trap, with a south-west dip. Limestone breccia is the gangue and hanging wall of the bed. The latter varies from 3 to 12 feet in thickness.

Since time of visit some 60 tons of ore have been raised, which appears to be about all that remained in the mine, and which could have been just as well won from the old slope workings as from the expensive shaft that was put down.

Several leaders of ore were followed out on each side of the old slope, but all pinched into rock in short distances. The mine at present is abandoned and filled with water.

The ore seems to be a western extension of the most northern Wheatfield mine opening, and the following analysis, made by Messrs. Booth, Garrett, and Blair, Philadelphia, March 2, 1882, shows its character:

Metallic iron,	42.573
Silica,	21.850
Alumina,	3.270
Lime,	2.080

This analysis shows no determination of phosphorus or sulphur, so that it can hardly be compared with the Wheatfield ore.

The analysis was kindly furnished by the Monocacy Iron Company, who carried on the last mining operations.

This whole Southern Range or Conglomerate Series of Magnetic Iron Ore mines, extending from Boyertown on the east to Fritztown on the west—a distance of over 20 miles—furnish fully 60% of the present output of magnetite in the county; and if we add to this the tonnage of the Jones Mine, (magnetic,) in Cærnarvon township—to be described elsewhere—this percentage will be further increased.

The various analyses of the different openings along this range will show the generally excellent character of these ores, which, while not running very high in iron for mag netic ores, are low in phosphorus and silica.

They are readily fluxed, owing to the character of the

gangue rock, so that they are always in demand in the Schuylkill Valley for mixture with the more refractory South Mountain magnetites and softer limonites of the Great Valley.

The future of all the present openings on this range is encouraging, and their past history should furnish an incentive to more thorough and systematic exploration in other parts of the range.

Chapter IX.

Red Hematite Ores.

The occurrence of this kind of iron ore in a workable shape in Berks county is of considerable importance, and it is desirable to discover its geological relationship.

Pure red hematite, or specular iron ore is 70 per cent. iron and 30 per cent. oxygen; but as it never practically occurs pure in nature, the rūn of mines in Pennsylvania seldom exceeds 55 per cent. iron, and often much less.

The ore is known at once by its blood-red color when crushed or scratched. In Berks county it shows two varieties: 1. A massive, crystalline ore, of dark steel-gray color and metallic luster, weathering reddish; passing into: 2. An earthy, uncrystalline ore, varying in color from blood-red to brown.

The Dotterer mine is the only one in the county which shows the ore plainly. In Lehigh county the openings around Zionsville and Shimersville seem to place their ore underneath dark chlorite slate, and over decomposed feldspathic gneiss.

At the Dotterer "Red Oxide" mine, in Earl township, Berks county, the ore seems to lie in deep-red colored slate, upon a conglomerate of gneiss and Potsdam sandstone pebbles. See Fig. 17, page 355.

In northern New York red hematite is mined beneath Potsdam sandstone, and above slates. The Lock Ridge range of magnetic iron ores in Berks county (described in Chapter VIII) seems to occupy this position.

In Virginia, where the Potsdam (No. 1) formation is a couple of thousand feet thick, consisting of interbedded conglomerates, sandstones and shales, these red hematites or specular ores seem to occur in the lower slates Mr. A. S. McCreath in his "Mineral Wealth of Virginia," page 9,

divides the formation into 1, lower slates; 2, sandstones; 3, upper slates.

All three divisions are iron-bearing; but the *lower slates* have been extensively developed in Augusta, Rockbridge, Botetourt and Bedford counties for the *red hematites*, the other two members carrying the *brown hematites* or *limonites*. The red hematite there is often intimately mixed with small quartz grains.

The New Jersey red hematites are placed by the reports of that State between crystalline limestone and the underlying gneiss. But in Berks county such crystalline limestones resting on gneiss in connection with iron ore are wanting. It is, therefore, not yet clear what are the precise geological relationships of the Berks county red hematite ore.

Micaceous red hematite is as yet only known in one locality in Berks county—the Fritz Island Mine—in the Schuylkill, south of Reading, and is not in sufficient quantity to work.

The Dotterer Red Oxide Mine:—This mine is located about 500 yards south of the dwellings of N. H. Landis and J. Dotterer, and on land of the latter in Earl township.

It is about 2 miles due west, air line, from Hill church.

It is close to the summit of Saw Mill hill, whose west flank and crest is composed of Potsdam sandstone, forming a conglomerate with the gneiss on the east flank along the ridge of the hill. A vertical section and ground plan of this mine is shown in Figs. 17 and 18, page 357.

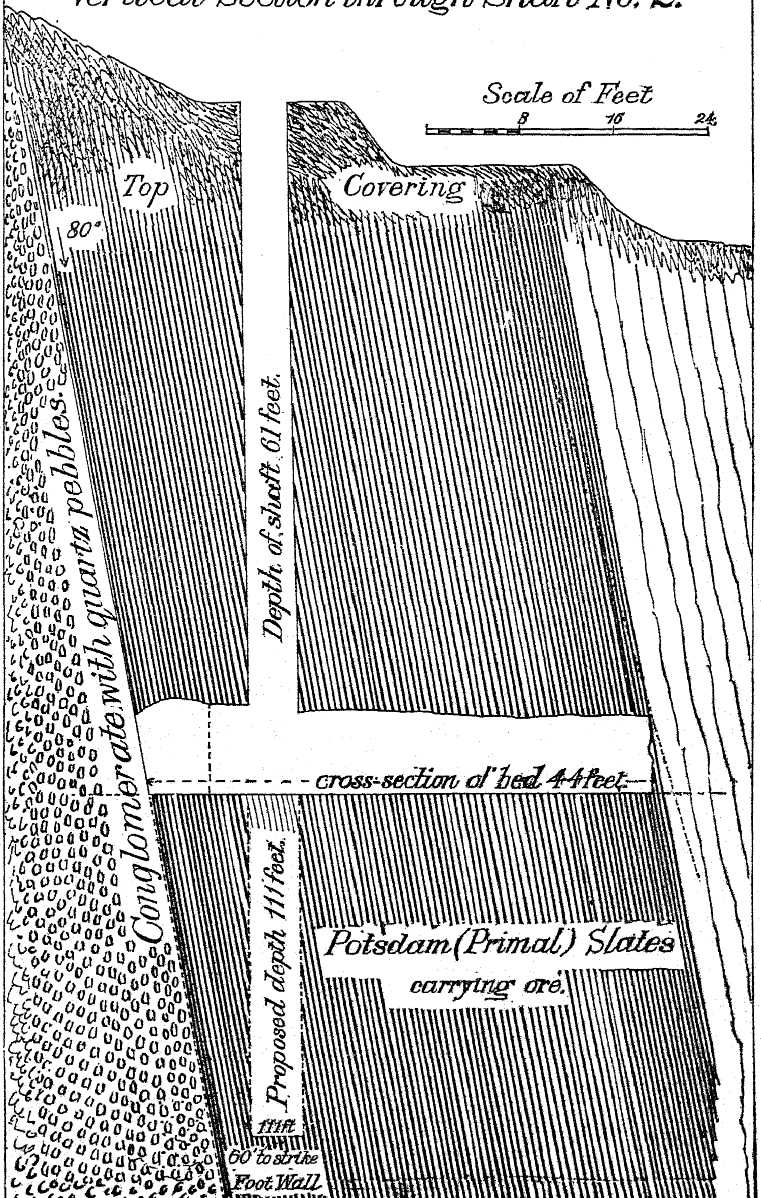
The mine was idle when visited, but the following notes were obtained from Mr. Griffith Jones, who, with the Messrs. Gabel of Pottstown, have leased the mine.

There are three shafts on the property; No. 1, the most northern, being 66′ 4″ deep; No. 2, the middle shaft shown in the figure, 61′, and No. 3, or south shaft, 50′ deep.

The ore occurs disseminated through a chloritic slate (lower Primal ?) dipping conformably with foot and hanging wall about S. 45° E. 70° to 80°.

No. 2 shaft was put down all the way through these ferriferous slates, and at the depth of 61′ a drift was driven

Fig. 17. Dotterer Red Ore Mine.
Vertical Section through Shaft No. 2.



N. W. 12′ to strike foot wall, and a gangway then driven south along foot wall for about 60′, and a rise put up at the end to meet shaft No. 3, 50′ deep.

This gangway was likewise driven north for 15′, and from the top of a winze a counter gangway was driven in slates 36′ to strike No. 1 shaft.

Between Nos. 2 and 3, and about 45 feet from the former, a cross cut was driven south-east through iron-bearing slates, 44 feet long from foot wall, without reaching the top rock.

The mine was again started in the late fall of '82, when it was contemplated to carry No. 2 shaft down to a depth of 111 feet, at which depth it would probably strike foot wall on a 70° dip.

The foot wall has been explored for 75 feet along strike of ore, which seems to be everywhere a rich argillaceous slate, high in alumina, but rather lean in iron, and carrying titanic acid.

It has been used in the past by the Phœnix Iron Company and the Pottstown Iron Co., both of which have condemned it; but it is only fair to state that Mr. Jones has great expectations of a "better deal," as is evidenced by the extensive preparations he has made for continuing mining.

[Since the above was written Mr. Jones has commenced active operations there, and is hauling his ore across the South Mountains to Bechtelsville, in Washington township, for use in the reconstructed Norway furnace (formerly the Lawrence furnace.)]

The furnace is being run entirely on "home ores," and the Dotterer "Red Hematite" is largely used with the more refractory magnetites.

No limonites are used whatever up to date of writing, (February 22, 1883,) as the following record of charge will show:

Ore.

	Pounds.
"Black" Boyertown magnetic ore, (Gabel mine,)	1534
"Blue" " " " " "	383
"Blue" " " " (Rhoades vein, Phœnix,)	383
Black Barto magnetite, Landis mine, ...	350
Red hematite, Dotterer mine, ...	350
	3000

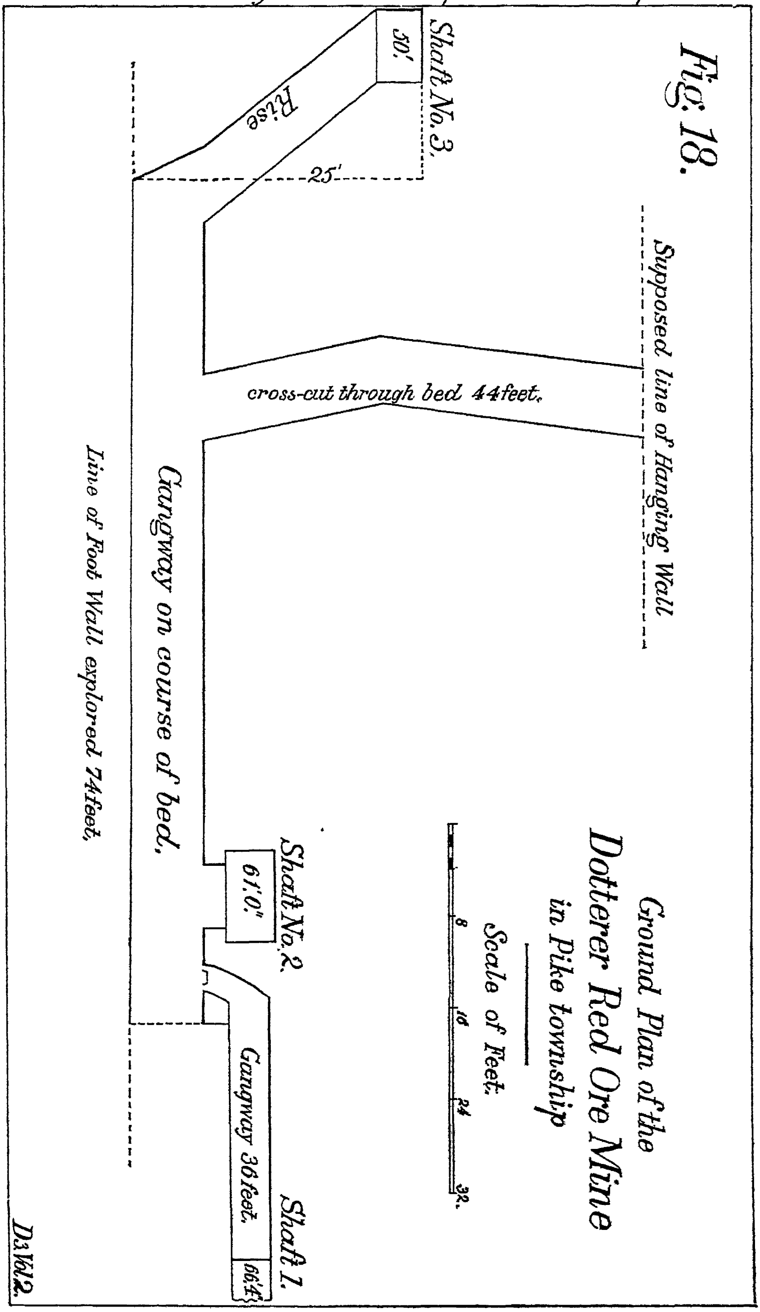


Fig. 18.
Ground Plan of the
Dotterer Red Ore Mine
in Pike township
Scale of Feet.
8
16
24
32.
Supposed line of Hanging Wall
Shaft No. 3.
30'
Rise
25'
cross-cut through bed 44 feet.
Gangway on course of bed,
Line of Foot Wall explored 74 feet,
Shaft No. 2.
61'.0"
Gangway 36 feet.
Shaft 1.
66'.4"
D3 Vol. 2.

Fuel, coal,	1750
coke,	250
Flux, limestone,	1300

The slag from this blast was analyzed by Mr. Charles I. Rader, of the Phœnix Iron Company, as follows:

Silica,	32.40
Alumina,	13.69
Oxide of iron,	1.91
Lime,	42.72
Magnesia,	6.21
Sulphur and undetermined matter,	3.07
	100.00

A considerable amount of this ore is piled up at the furnace, and on February 20, it was sampled by Mr. J. H. Harden, of the Phœnix Iron Company, in the presence of Mr. Jones and myself. A box full of ore was taken from various parts of the stock pile, and expressed to Mr. A. S. McCreath, who forwards me his results as follows:

Metallic iron,	17.550
" manganese,	.201
Sulphur,	.027
Phosphorus,	.076
Alumina,	24.314
Titanic acid,	4.970
Lime,	.380
Magnesia,	0.926
Silica,	32.960
Carbonic acid,	None.

"The analysis speaks for itself. A furnace must be running on a very rich mixture when it becomes desirable to use a certain proportion of this 'ore.'"

I don't know what Mr. Jones claims for this ore other than its being a partial flux; but when he has to get rid of nearly 5 per cent. titanic acid and 33 per cent. silica in the ore itself, even this element of its value for use with the more refractory magnetites is considerably reduced. He naturally prefers the soft, earthy portions of this ore, as being most free from silica; but in a miscellaneous furnace charge it is impossible to separate the two varieties, and an equal mixture of both was taken for the sample. Not wishing, however, to suppress any evidence bearing on the constitution of this ore, I present, without comment, an

analysis by Mr. H. W. Hollenbush, of Reading, from a sample sent him by Mr. Jones, and also append Mr. Hollenbush's remarks :

Pure metallic iron,	33.00
Oxygen with the iron,	13.50
Alumina,	27.30
Silicious matter,	19.93
Carbonate of lime,	.53
Carbonate of magnesia,	.36
Potash,	.60
Phosphorus,	.04
Sulphur,	None.
Titanic acid,	None.
Water,	4.74

"This argillaceous ore yielding potash would do very well to work with hard fluxing ores, and would give a very good iron."

Mr. M. P. Janney, of the Pottstown Iron Company furnishes the following partial analysis of the ore, made February 20, 1880, from stock then being used at the company's furnace :

Insoluble residue in HCl,	Alumina,	69.75=	23.50
	Silica,		40.35
	Iron and alumina,		21.75

The material as ore is positively worthless and Mr. Hollenbush's sample must have represented a very choice article not usually seen on the ore dump.

Some red hematite of an excellent quality has also been mined in Furnace hill, Earl township, at *Kaufman & Spang's* old mine, about 1 mile east of Spangsville.

There are several open cuts here on the hill, and a tunnel was driven in from the road to intersect the ore. The mine has been long abandoned, and the old workings being all closed up, nothing could be learned of the position of the ore.

It appears, however, to occur in the Potsdam sandstone, which everywhere crops out here as a hard, compact quartzite.

Several pieces of ore lying at the mouth of the old tunnel were collected for the survey cabinet; it shows a hard, compact, crystallized ore, with a bright metallic luster, and excellent quality.

The mine is said to be exhausted, and even specimens of the ore are rare. It is the only known locality in the county that has furnished specimens of magnesite (carbonate of magnesia) mentioned in Genth's Report B, page 157.

Rockland township has also furnished a little specular ore of a blood-red color and earthy texture, showing no crystallization whatever.

It occurs in *P. Brumbach's ore holes*, in close proximity to limonite, both in Potsdam sandstone, situated on hill about 1 mile west of Green Hill tavern, near which the old Rockland forges formerly stood. The ore is of a good quality, but though the hill is riddled with small shafts and holes, no great quantity of ore seems to have been produced.

As far as I could judge, it occurred more as surface pocket of ore than in any regular bed, though owing to the utter abandonment of the mines, no examination could be made in the shafts.

The valuable nature of this ore, and its ready sale when found, should lead to a more thorough search for it in the Potsdam sandstone formation, or near its various junctions with the older Azoic rocks. At present, its insignificant development makes it of but little value in a commercial sense, but it is well worthy of a more energetic research.

CHAPTER X.

The Brown Hematite Ores of the South Mountains.

This kind of iron ore is not rich in iron but greatly excels in quantity the magnetic and specular ores described in the preceding chapters. If perfectly pure (which it never is) it could not yield more than 60 per cent. of iron; the run of the best mines is about 50 per cent. There is about 14½ per cent of water in the pure ore.

No brown hematite ore beds are known to exist in the gneiss rocks of the South Mountains. Nor could they be expected to exist there, for the general change of all the rocks by heat and pressure would have changed any brown hematite ore bed into magnetic and specular ore beds.

The brown hematite ore beds of the mountain region, then, are found in connection with the Potsdam sandstone and overlying limestone, where these have been saved from erosion, in the synclinal troughs or valleys and along the lower slopes. A range of ore outcrops runs along the south edge of the Great Valley, at the north foot of the mountains; but these will be described in a subsequent chapter of this report. In this chapter only the mines of the mountain region will be noticed.

The ore occurs in all its varieties—massive, concretionary, fibrous, botryoidal, mamillary; frequently coated with shining black manganese, and showing those chemical changes called by mineralogists *göthite*, *turgite*, *lepidocrocite*.

The ores connected with the Potsdam sandstone are all silicious, hold phosphorus, make cold-short iron, and show small percentages of alumina, magnesia, and lime. (See analyses further on.)

The ores properly belong, however, not to the sandstone strata, but to *damourite* or *hydro-mica* slate beds overlying the sandstones. This slate, always holding some iron,

sometimes becomes so loaded with iron as to be an iron ore. It decomposes into two parts, more or less mixed—masses of brown hematite iron ore, and masses of tough, unctuous clay, containing potash and magnesia, the clays often remaining in their original situation as slates so as to mark the stratification; at other times being contorted, confused, and amassed in depressions of a later age.

The ore usually occurs in small fragments, mixed with sand or flint, from which it is separated by washing. Its color varies from dark brown red to straw yellow.

Udreé ore bank in Ruscombmanor.—The largest production of brown hematite ore in the mountain district of Berks county at present is at this bank, belonging to the Clymer Iron Company.

It is opened on the north flank of Furnace Hill, about 1½ miles S. W. of Pricetown.

The ore occurs in Potsdam sandstone close to the junction of the Laurentian rocks, which come in about 200 feet west of opening, and spread out thence over the whole western end of the hill.

When visited, June 19, 1882, the mine was being actively worked under the superintendence of Daniel Rauenzahn.

It is owned and has been worked since 1871 by the Clymer Iron Co. for its Mt. Laurel furnace.

The ore is limonite, mostly wash ore, but showing varieties of bomb-shell ore, hollow inside and filled with clay and water, and coated inside with an incrustation of manganese oxide.

Some handsome specimens of concretionary and stalactitic ore have been obtained here, as well as the varieties göthite, lepidocrocite, turgite, red and yellow ocher.

The ore is very silicious and "cold short," which latter defect prevents its use in the Oley charcoal furnace near by, belonging to the same company, and compels its transportation 6 miles to the Mt. Laurel furnace, costing 60 cents per ton haulage.

The ore is cheaply mined, however, from an open cut about 70 feet deep, the ore body dipping about N. 20° E. 70, and averaging 20 feet in thickness. The ore is opened

up about 300 feet along line of outcrop, and the bed is slightly split up with horses of clay, which are largely found in the mine.

The mine yields from 18 to 20 tons a day, though capable of much higher development; employs 12 men.

The ore is hoisted on an incline with double track, by a 35-horse power (Archambault, Philadelphia,) engine, and is dumped directly into a single washer 26 feet long, and with a capacity of 50 tons.

A small water pump is all that is necessary to keep the hole dry, the water for washing being obtained from a well near the engine house. Hoisting engine has a double gearing 15′ driver, and 39′ fly wheel.

The following analysis is by McCreath, from a sample sent him from the bank, which shows:

Metallic iron,	40.050
Metallic manganese,	3.314
Sulphur,	.003
Phosphorus,	.522
Silicious matter,	22.440
Phosphorus in 100 parts iron,	1.30

Weaver Mine, in Oley township.—This is situated about 1¼ miles S. E. of Friedensburg, on property of Mrs. C. Weaver.

The ore is limonite, most of that now used being surface wash ore, though in the past many beautiful specimens of lump and shell ore have been gathered from here.

The mine is opened at the junction of the Oley slates and No. II limestone, the line of contact, in fact, crossing through the middle of the open cut surface workings.

The mine at present is being worked by the Clymer Iron Co., all the ore being used at the Oley Charcoal Furnace, where it is considered a very free working ore.

No greater proof of the importance of locating the damourite slate beds—so often ore bearing—can be deduced than from an inspection of this mine.

This slate, decomposed to an argillaceous white and buff colored clay, is largely used right at the mine for making

an excellent quality of building brick, largely used at Friedensburg. The occurrence of this ore close to the slate indicates what is really the case, viz: the persistency and permanent character of this bed as compared with the deposit in the Hunter mine, 300 yards distant, (N. W.,) which is entirely in limestone.

Weaver's mine has been worked for about 17 or 18 years and now averages from 10 to 15 tons per day, giving employment to 10 men. One 20-horse power (Wren & Bro., Pottsville,) engine is used for pumping and running the washer, using both wood and coal, 1½ cords per day of 11 hours, at $1 50, and ½ ton anthracite coal @ $3 60 per ton delivered at mine.

The ore is carted to Oley furnace 3½ miles @ 65 cents per ton by four single teams owned by the company. There is ample water for washing obtained from a well at the mine.

The ore dips from 30° to 50° to the north-west *away* from the slate hill to the east of it, and occurs in a bed from 2′ to 8′ thick underlaid with clay, or decomposed damourite slate. There is a royalty of 35 cents on the ore—which generally throughout the mine is composed of 25 per cent. lump and 75 per cent. wash, though operations now are confined to surface digging which is mostly wash ore.

By reference to contoured sheet XI in atlas, shaft marked No. 1 was sunk in 1878 to the depth of 66 feet. At 49′ a 2-foot bed of hard ore was struck dipping N. W. about 30°.

At 56′ a good 8-foot ore bed was struck, 50 per cent. lump—the parting of 7 feet being clay, which also occurred under 8-foot bed.

The second bed was almost flat, with a slight N. W. dip. A gangway driven north-west in this ore struck 2-foot bed 30 feet out from shaft, the large bed in that distance pinching out to nothing. Both beds at this point continued with the dip of the upper bed about 30°, and with no increased thickness.

At west end of engine-house another shaft was sunk in search of water 116′ all through clay to bottom rock, limestone.

At 104 feet, a gangway was driven *east* 32′ through clay when work was stopped on account of water. The drift being

hastily constructed fell in, owing to the soft nature of the ground, and was completely choked up. A little solid slate and dirty ore was found here.

At 100′ down from surface a gangway was driven west 32 feet, and after going through 4 feet of clay ore was met with.

The search was still for water and the gangway was driven 6 feet wide, 4 feet on the south side being in clay and 2 feet on the north side in ore.

Ore was followed 16 feet out from shaft then turning north; the remaining 16 feet proving dry ground

A small drift was driven north 10′ from where the ore left gangway to prove thickness of bed, going 5 feet through ore and 5′ through clay, so that at this point the ore was about 7 feet thick, with a pretty stiff north-west dip.

This is very likely the same ore struck in No. 1 shaft between 50 and 60 foot level, as the distance between shafts is great enough to allow of this ore dipping at 30° to come in at 100-foot level in No. 2. The ore body in the latter shaft was of good quality and dipped between 30° and 40° N. W.

When all these attempts to find water failed, it was decided to tap water found in the east drift by a circuitous and carefully constructed gangway. Accordingly an adit was started due north at 104′ below surface which turning gradually to the east in a half-moon shape, was carried around 71′, successfully striking the water after going through similar slate and rotten ore to that mentioned in the east drift.

This is the source of the present plentiful water supply for washing purposes. The mine has a good future, and its ore is of very fair quality as the analysis below—kindly furnished by Mr. Abraham Schweitzer, of the Clymer Iron Company—will show; H. W. Hollenbush, Chemist.

Oxide of iron,	52.40
Oxide of manganese,	1.20
Alumina,	13.21
Lime,	0.36
Magnesia,	trace.
Phosphoric acid,	0.30
Silica,	18.64
Water by ignition,	11.28
Total,	97.99
Metallic iron,	36.68

Siderite or carbonate of iron is said to exist here, and I was shown a piece of it which undoubtedly is properly named, but to what extent it is not known. It is more than likely to be very small, for the miners seem to know very little about its occurrence.

Hunter Mine in Oley township.—This mine is located about 300 yards N. W. of the Weaver mine, on the old Kemp farm, now owned by Daniel Hunter.

It was entirely abandoned when visited.

Though opened after the Weaver mine, it is considered to be pretty well exhausted, not being as favorably situated as its neighbor, as it is wholly in limestone.

It was entirely filled with water to within 10 or 12 feet of the surface when visited June, 1882, and showed an open cut of small dimensions, the sides of which were composed of a buff-colored limestone clay.

Considerable money and time have been spent here by different parties. It was originally leased by the Clymer Iron Co., who only sank a few trial pits. Bailey, of the Pine Iron Works, next took hold of it, leasing for 10 years at 50 cents per ton royalty.

At the expiration of five years they threw up the lease, which then passed into the hands of Griffith Jones of the Gabel Co., who sank shaft No. 1, (see Atlas sheet XI,) located about 50 feet south-west of cut.

This shaft was from 90 to 100 feet deep, first through yellow clay 90 feet $\pm$, then 1 foot of white kaolin, and then a little brown hematite 1 to 2 feet thick.

Under this there was a little black clay containing balls of carbonate of iron, and at bottom of shaft a thin stratum of mixed black clay and limonite.

Their object was to discover a 7-foot bed, said to exist there by the owner of the property, not finding which they threw up the lease.

Mr. Bailey, in order to get water, sank a shaft at the engine house 125 feet, 20 feet through clay and the rest through limestone, showing the varying character and thickness of the clay deposit.

The open cut, from which he got his surface ore, is said to be 50 feet deep in clay, and a shaft was sunk 50 feet more from bottom of pit to limestone and clay mixed.

He also sank shaft No. 2, about 250 feet north from engine house, 80′ to 84′ feet deep, which went through 20 feet limestone clay and soil, a little ore (2′), then slate and bluish gravel all the rest of the way, according to report.

Yellow ocher and clay, mixed with slate, spreads over the field and along the public road, the latter dipping a little south of east 20°, on the public road, at junction of limestone and slate.

A couple of hundred feet north-east of the cut limestone outcrops in place, dipping S. 48° W. 22°.

There is a considerable mass of slates to the south and west of the mine, and further exploration should be carried on near this hill.

Kaolin.—There is a considerable body of *Kaolin* at this mine, consisting mostly of two varieties—a pure white and a buff-colored argillaceous clay, colored with iron.

The deposit has been worked under a lease to Theodore Ludwig of Douglassville, and 'Squire Mauger. The bank was idle when visited, but there were a few tons of No. 2 white and yellow kaolin in the sheds.

The best quality, No. 1, white, used in weighting paper, used to sell at $7 to $15 per ton, and was successfully used at Connard's paper mill at Pleasantville, and at Spring City opposite Royer's Ford.

Mr. Burgess, proprietor of the paper mill at the latter place, took the first 100 tons of No. 2, white, @ $9 per ton.

Mr. Ludwig divides the kaolin, according to quality, into three grades: No. 1, white; No. 2, mixed white and yellow; No. 3, buff color.

He has pretty well exhausted the first quality now, which, he says, he got under about 6 feet of top covering, in a face 30 feet long and 20 feet wide.

It showed no persistency, however, and soon pinched out.

There is still a considerable amount of buff-colored clay.

There was about 800 tons of the three varieties named, which, according to Mr. Ludwig, brought from $6 to $15 per ton, and, as it could be mined cheaply, the venture should have proved a profitable one if the No. 1, white, bed had been more persistent. There is also said to exist a blue clay, hitherto undeveloped, and lying rather low in the mine.

The *kaolin* is of excellent quality and deserves further development. A sample of the best white that could be found at the pit was sent to Mr. McCreath for analysis. His results will be found below together with other clay analysis for comparison:

	(1)	(2)	(3)	(4)
Silica,	66.170	65.10	73.00	71.80
Alumina,	19.890	22.22	19.93	19.05
Potash,	...	0.18	.89	.61
Lime,	0.260	0.14	.39	.31
Magnesia,	1.902	0.18	..	.79
Protoxide of iron,	0.783	1.92	.87	1.31
Alkalies and undetermined,	6.211	0.06 (Phosphoric acid.)		..
Water,	4.784	9.86 (water and organic matter.)	6.40	6.08
	100.000	99.66	101.48	99.95

No. 1. Kaolin clay from Hunter mine, Kemp farm, McCreath.

No. 2. Best English Stourbridge clay, such as is used for making glass-pots and fire-brick. Percy's metallurgy.

No. 3. Bremen, Germany, clay used for making glass-pots; from New Jersey report 1868, p. 684.

No. 4. Clay from the Morgan clay pits near South Amboy, used for making common pottery and stoneware, and known as potter's clay. New Jersey report, 1868, p. 688.

The Berks county clay or kaolinite shows a striking similarity of composition with these given above, all of which have been tested and considered admirable for their several uses.

Manwiller mine in Oley township.—Brown hematite or limonite has also been found in the Oley valley at the *Manwiller mine*, situated about 1¼ mile W. N. W. of Griesermersville, and entirely in the limestones of No. II. This

mine was started in 1873 and abandoned in 1878. There is a fair showing of lump ore in the cut, but the whole deposit is only a pocket, similar to those opened weekly, one might say, in the middle of the great valley, and the best of it is worked out. Mr. Fegley, of the Warwick Iron Company did most of the mining here and is said to have taken out about 2,000 tons. The royalty was 35 cents per ton.

Washington township has been a small producer of limonite, a bed of which is exposed in the little Dale Forge limestone valley, and can be seen outcropping on the east bank of the Perkiomen creek near D. Richard's house, close to the junction of No. II and gneiss, Potsdam S.S. being absent on that side of the valley.

It can be followed north through the Schall estate to near the Schall upper limestone quarry, where it was somewhat developed and showed, according to Mr. D. H. Schall, a 7′ bed of good ore. Limonite was likewise found in the same valley at *J. Rush's ore pit*, near the public road to Huff church, and in Hereford township, from which four to five thousand tons were taken out and used by the Thomas and Pottstown Iron Companies, though it has now been idle for 10 years and is entirely filled with water (the alleged cause of its abandonment.)

No information could be obtained as to the quality of this ore from either of the companies named, owing to the period of time that has elapsed since its use. The cut is lined with a decomposed limestone clay.

Bittenbender Hematite Bank, in Hereford township.—This mine is on lands of C. and S. Bittenbender and heirs of J. B. Gehman, about ½ mile south-east of Siesholtzville, and in the valley of the Perkiomen creek.

The bed here runs parallel to the more extensive magnetic ore workings higher up the hill, and about 800 feet to the south of them.

The Crane Iron Company got a lease on the Bittenbender portion of the tract in 1866, erected a washer, and commenced mining.

They worked about 3 months on the Samuel Bittenbender portion, and mined about 100 tons @ 30 cents, royalty. On the Christopher Bittenbender tract work was carried on without interruption till 1871, when the lease was thrown up. In this time—5 years—5 000 tons were mined and sent to their Lehigh furnaces.

The greatest depth attained was 60 feet in open cut. The gangue was limestone and clay, though it was said to have been abandoned on account of the great quantity of flint (P. S. S. ?) found mixed with the ore in the lower portion of the cut.

In 1872, Henry Schankweiler obtained the lease, but was soon compelled to give it up, and in 1879 it passed into the hands of R. Moll and Peter Worst, who, however, did very little mining.

After passing through the hands of George Hess and C. Ziegenfuss, Geo. Greis & Co. got hold of it. They erected a small washer, and mined about 50 tons of it, which was sent to Catasauqua. It has since been idle.

On the J. B. Gehman heirs' tract adjoining, Messrs. Hartzel and Shimer took out a lease in 1873.

They washed about 1,000 tons of ore, which still lies on the dump, condemned on account of its high percentage of silica.

Some further work was done in 1880 by Messrs. Smink & Morganroth, who sank a 60-foot shaft, but finding no improvement in the character of the ore, all work was stopped.

The ore on the dump here seems to be all wash ore, and so highly mixed with silica, that it was thought useless to sample it.

The position of these three openings will be seen from the Index Map, the S. Bittenbender mine being nearest the magnetic ore openings, Christopher Bittenbender cut near the public road to Perryville, and Gehman opening down the valley towards Hampton Furnace.

Rockland township has also claimed some little attention from its limestone ores, but hitherto exploration outside of one or two mines down towards the limestone valley of

the East Penn R. R., has been carried on to a limited degree.

Some very good cabinet specimens of bomb shell ore were picked up at the two or three small brown hematite openings in Potsdam sandstone about ½ mile south-west of New Jerusalem, and about 300 feet N. W. of Israel Heist's house.

These holes are 30 to 40 feet deep, and seemed mostly in clay. The locality deserves some further testing.

Further down the road about 300 feet, towards *Souder's mill*, there are several trial pits and shafts located, none of which seem to have produced any favorable results.

Limonite has likewise been found in this hill about 500 yards N. E. of *Souder's mill*, in Potsdam sandstone, and close to its junction with the Azoic rocks.

Some ore has been mined here by Henry Bieber, but nothing could be learned about it, owing to everything being closed up, and Mr. Bieber's whereabouts not being known.

Crossing Pine creek and ascending the Potsdam hill on the west, limonite has been found about 1 mile west of Green Hill tavern, at Percival Brumbach's mine.

The ore here seems to be a mixture of red hematite and limonite, and though several small shafts have been put down and pits opened, very little of either was to be seen.

Further west, and near summit of hill, some small trial pits have been put down by Daniel Fisher, but there was not a hatfull of ore to be seen when visited.

This Potsdam ridge is connected with a belt of ore-bearing sandstone, coming up from the East Penn Valley from east of Fleetwood, which has been variously tested for iron ore.

One of the most recent openings is the

Schweitzer & Kutz Mine,

situated about 1¼ miles N. E. of Pricetown, on the north flank of the South Mountains.

When visited on September 22, 1882, the mine had only been in operation about 5 months, and on that day was

suffering for want of pumps to keep the cut dry from an accumulation of rain water, so that the bottom could not be seen. A considerable pit had been dug down against the face of the hill.

The ore has a S. E. dip into the hill (overturned, no doubt,) of about 45°, and has a sandstone bottom, and a decomposed damourite slate and clay for a top.

The bed is said to be 12′ thick, though no such thickness was exposed at time of visit.

The ore was $\frac{3}{4}$ wash and $\frac{1}{4}$ lump, all washing being done at the mine; average 10 tons a day.

The ore goes to the Temple Iron Co., and is shipped from Fleetwood, 2 miles distant, @ 60 cents per ton haulage. The engine house is supplied with one 10-horse power pumping engine, consuming $\frac{1}{4}$ ton of coal a day, @ $3 40 per ton at mine.

The mine lies in the woods east the public road, and is consequently easily overlooked. It is located on the Index map.

Old Millert mine.—About the same distance west from the same public road to Fleetwood the old Millert mine is located, which on same day showed an abandoned cut of considerable size, about whose production nothing was learned.

Shæffer's new mine at Fleetwood.—Late in the fall of 1882 a new limonite mine was started by Ad. Shæffer at Fleetwood, close to the public road from Blandon to Pricetown, and about 1 mile S. E. of the former place in Maiden Creek township.

They had just commenced operations here, washing the surface ore from a 6-foot pit, the ore going to the Temple Iron Company at Temple.

The mine is entirely in Potsdam and the ore very silicious.

Muhlenberg mine.

West of Reading, and just north of the Spring-Cumru

township line, there are three limonite banks, only one of which, the Muhlenberg (Beidler) mine, the middle one of the three, was being worked in 1882. It is in limestone, and shows a considerable body of silicious hematite.

The bank is worked by an open cut not over 30 feet deep, and shows some slate and clay mixed with ore.

Mr. A. S. McCreath took samples from here, as well as from the two other mines. His analysis of this ore was made from 80 pieces and dried at 212° F. It shows:

Metallic iron,	41.450
Sulphur,	.019
Phosphorus,	.205
Silicious matter,	25.340
Phosphorus in 100 parts iron,	.494

Seitzinger bank is located about 1 mile east of the Muhlenberg mine, and nearer to Reading.

It is likewise in limestone, which outcrops in its east and south sides.

The rest of the bank has all fallen in, and the sides show loose linestone soil and reddish slate. No ore was seen here except a little on the dump, which shows a good deal of iron pyrites highly decomposed.

Mr. McCreath's analysis from 120 pieces shows the following constituents:

Metallic iron,	43.750
Sulphur,	1.017
Phosphorus,	.104
Silicious matter,	21.090
Phosphorus in 100 parts iron,	.237

Eureka bank, on Jager farm, 3½ miles west from Reading, is the third, and the description of the Seitzinger bank will pretty nearly apply here.

The ore seen, however, was cellular and cleaner and showed little or no pyrite.

The cut is about 40 feet deep, though abandoned now.

Some manganese oxide coatings are seen here also.

The following is McCreath's analysis, sample 90 pieces, from old dump at mine:

Metallic iron,	48.375
Sulphur,	.018
Phosphorus,	.132
Silicious matter,	14.410
Phosphorus in 100 parts iron,	.272

There is a small hematite opening on west flank of Potsdam sandstone hill, shown at extreme end of Index map, located close to road leading over hill at this point.

It was abandoned when visited and showed little or no ore. The other hematite mines are wholly confined to numerous openings in the East Penn-Lebanon valley, and will be described by themselves in the chapter on the Great Valley.

Chapter XI.

Catalogue of specimens collected in 1879–1882.

When the topographical work of 1879, 1880, 1881 was about finished, complete suites of the varieties of *mountain gneiss*, *Oley valley limestone*, and *magnetic iron ore*, were collected for the museum and for analysis. To these where added typical specimens of *Potsdam sandstone*, *Mesozoic shale*, *sandstone*, *conglomerate*, and *trap*.

No special collecting was done in the Great Valley proper.

The *museum numbers* run from 8975 to 9244. The *field numbers* are given in brackets.

8975 (1) Blue limestone, massive. Property and quarry of Samuel Marquart, 1 mile S. E. of Oley Line hotel, Oley township.

8976 (2) Bastard limestone, on farm of Samuel Kauffman, E. bank of Monocacy creek, ¼ mile S. from Oley Line hotel, Exeter township.

8977 (3) Fine-grained black trap (Basalt) from south end of same quarry.

8978 (4) Ditto—from S. end of same quarry.

8979 (5) Limestone, blue, with quartz veins, from ditto

8980 (6) Ditto—soft blue, N. end of same quarry

8981 (7) Ditto—thinly bedded—S. end of John Snyder's quarry, 300 yards from Oley Line hotel, Exeter township.

8982 (8) Ditto—from N. end of same quarry.

8983 (9) Ditto—quartzose—on Oley and Exeter township line road, 200 yards S. from Oley Line hotel, property of John Snyder.

8984 (10) Light grey silicious limestone—from Oley and Exeter township line road, at school-house, Oley Line hotel.

8985 (11) Dark blue limestone—from center of Albert Knabb's quarry, ½ mile N. of Oley Line hotel, Exeter township.

8986 (12) Ditto—quartzose—from west end of same quarry.

8987 (13) Blue limestone—from quarry on west bank of Monocacy creek, 500 feet west of Oley Line hotel, Exeter township.

8988 (14) Blue and white crystalline limestone—back of Benjamin Ritter's barn, 1 mile N. E. of Jacksonwald, Exeter township.

8989 (15) Dark blue limestone—on Oley pike, Charles Breneiser's farm, 1¼ miles N. E. of Jacksonwald, Exeter township.

8990 (16) Blue limestone—from center of Benjamin Ritter's quarry, ¾ mile N. E. of Jacksonwald, Exeter township.

8991 (17) Blue limestone—quarry at kiln, farm of C. Tyson, ⅛ mile E. of Jacksonwald, Exeter township.

8992 (18) Hard blue limestone. E. end of Charles Dengler's quarry, 2½ miles west of Jacksonwald, Alsace township.

8993 (19) Blue limestone, from Oliver DeHart's quarry, 2 m. N. W. of Jacksonwald, Exeter township.

8994 (20) Light grey bastard limestone. James Koch's farm, 2 m. west of Jacksonwald, Exeter township.

8995 (21) Dark blue compact limestone. Center of Samuel Schweitzer's quarry, west bank of Antietam creek, 2 m. west of Jacksonwald, Exeter township.

8996 (22) Soft blue limestone. E. bank of west branch of Lime Kiln creek, Samuel Marquart's farm, 1 m. S. E. of Oley Line hotel, Oley township.

8997 (23) Blue limestone, with iron pyrites. Levi Knabb's quarry, 1 mile east of Oley Line hotel, Oley township.

8998 (24) Slaty blue limestone, from Ephraim Knabb's farm, 1 mile east of Oley Line hotel, Oley township.

8999 (25) Compact, grey limestone. George Raudenbusch's farm, from ditto.

9000 (26) Blue limestone. N. end of Ezra Griesermer's quarry, 1½ miles S. W. of Griesermersville, Oley township.

9001 (27) Blue limestone. Center of Levi Herbein's quarry, 1¾ miles S. W. Griesermersville, Oley township.

9002 (28) Cherty limestone. West end of ditto.

9003 (29) Calcareous slate. N. side of road, farm of D. C. Butz, from ditto.

9004 (30) Blue limestone, bedded. John G. Fischer's quarry, at kiln, 1 mile N. W. of Yellow House, Oley township.

9005 (31) Blue limestone. West end of Levi Hartmann's quarry, at kiln, 1½ miles S. E. of Friedensburg, Oley township.

9006 (32) Ditto. Center of quarry, at kiln, on farm of Peter Guldin estate, 1½ miles S. E. of Friedensburg, Oley township.

9007 (33) Ditto; in quarry at kiln, Samuel Houck's farm, 1½ miles S. E. of Friedensburg, Oley township.

9008 (34) Blue massive limestone. Seth Grim's quarry, 2 m. S. of Friedensburg, Oley township.

9009 (35) Ditto; from Mrs. Col. J. Weaver's quarry, 2 miles S. of Friedensburg, Oley township.

9010 (36) Blue granular limestone. N. end of quarry, of Simon P. Guldin's estate, ¼ mile N. W. Yellow House, Oley township.

9011 (37) Grey limestone. Outcrop on Friedensburg road, ½ mile N. W. Yellow House, Oley township.

9012 (38) Blue limestone, with quartz veins. On Friedensburg road, ¾ mile N. W. of Yellow House, Oley township.

9013 (39) Blue banded limestone. East of Daniel De Turk's quarry, ½ mile N. W. of Griesermersville, Oley township.

9014 (40) Blue limestone, (brecciated.) Center of Lewis De Turk's quarry, ¾ mile N. W. of ditto.

9015 (41) Soft blue limestone. W. end of Ellis Winter's quarry, $1\frac{1}{2}$ miles N. W. of ditto.

9016 (42) Ditto. S. end of D. Kemmerer's quarry, near kiln, $1\frac{1}{4}$ miles N. E. of Oley Line hotel, Oley township.

9017 (43) Ditto; from center of quarry.

9018 (44) Hornblendic syenite, with small quartz veins, and large crystals of greenish, bronze-colored pyroxene.

From opening on summit of hill, property of D. Rauch, $\frac{1}{2}$ mile north from Huff Church, Hereford township.

9019 (45) Coarse, cherty blue limestone. Center of Peter Sneider, Jr., quarry, $\frac{1}{4}$ mile N. E. of Oley Line hotel, Oley township.

9020 (46) Grey bedded limestone. Peter Sneider, Sr., quarry, 1 mile N. N. E. of Oley Line hotel, Oley township.

9021 (47) Soft blue limestone. N. end of ditto.

9022 (48) Grey argillaceous slate. Outcrop at roadside, Levi Merkel's farm, $1\frac{1}{2}$ miles S. W. of Friedensburg, Oley township.

9023 (49) Ditto; from $1\frac{1}{4}$ miles S. W. of ditto.

9024 (50) Calcareous slate, quartz veins; at roadside, property of Levi Merkel, 1 mile S. of ditto.

9025 (51) Light blue silicious limestone. Center of F. V. Kauffman's quarry, on road from Friedensburg to Oley churches, $1\frac{1}{4}$ miles S. W. of Pleasantville, Oley township.

9026 (52) Soft blue limestone. Seth Grim's quarry, 2 miles S. of Friedensburg, Oley township.

9027 (53) Potsdam sandstone; from small quarry on crest Spies Church hill, 2 miles S. W. from Friedensburg, Alsace township.

9028 (54) Decomposed gneiss (granulite) E. bank of branch of Monocacy creek, property of John Hoch, $1\frac{1}{4}$ miles S. W. from Friedensburg, Oley township.

9029 (55) Granitic gneiss—from Capella hill—two miles west of Friedensburg, Alsace township.

9030 (56) Ditto—from hill summit, near Blind Hartman's tavern, 2½ miles W. of Friedensburg, Alsace township.

9031 (57) Brown hematite—bombshell, concretionary and botryoidal—Weaver's mine, 1 mile S. of Friedensburg, Oley township.

9032 (58) Kaolin—from Hunter's mine, Kemp farm, 1 mile S. of ditto.

9033 (59) Magnetic iron ore, in syenite, from old opening, on property of Mrs. David Knabb, ½ mile S. E. of Ohlinger dam, Alsace township.

9034 (60) Dark grey syenite, compact—hornblendic and altered feldspar, also pyroxene from Ohlinger dam road cut 3 miles N. E. of Reading, Alsace township.

9035 (61) Gneiss (granulite) with large crystals of quartz and pink feldspar—and some augite, from N. end of same cut.

9036 (62) Gneiss, consisting almost entirely of quartz and opaque orthoclase; also microline. The quartz contains numerous threadlike inclusions, possibly rutile, from N. end of same cut, immediately south of specimen No. 61.

9037 (63) Ditto—with more quartz and less orthoclase, middle of same cut.

9038 (64) Ditto—from S. end of same cut.

9039 (65) Fine-grained black trap, altered diabase, showing augite and magnetic iron-ore grains. On road to Babb's tavern, ¼ mile south-west of Ohlinger dam, Alsace township.

9040 (66) Magnetic iron ore, loose, from mouth of old shaft on hill summit ½ mile E. of Koch tavern, Alsace township.

9041 (67) Potsdam sandstone (bluish quartzite) from railroad cut in Neversink hills, 1½ miles S. of Reading depot, Alsace township.

9042 (68) Grey limestone, P. & R. R. R. cut, Neversink Hills, 2 miles S. of depot, Alsace township.

9043 (69) Blue limestone—from quarry at Big dam, base of Neversink Hills, 3½ miles S. of depot, Exeter township.

9044 (70) Potsdam sandstone (brown) P. & R. R. R. cut, Neversink Hills, 1 mile S. of depot, Alsace township.

9045 (71) Mesozoic conglomerate (Potomac marble) P. & R. R. R. cut, Neversink Hills, at Big dam, 3¾ miles S. of depot, Exeter township.

9046 (72) Coarse-grained trap (diorite) containing hornblende and feldspar, E. bank of Schuylkill river at canal rocks, at Little dam, 3 miles S. of Reading, Cumru township.

9047 (73) Syenite—fine-grained with hornblende and pyroxene, from cut on road to Babb's tavern, ¼ mile S. W. of Ohlinger dam, Alsace township.

9048 (74) Black syenite, showing large crystals of hornblende and pyroxene and some mica, distinctly stratified, from same locality.

9049 (75) Potsdam sandstone, white and fine-grained, Guldin Hill quarry, 1 mile N. W. of Jacksonwald, Exeter township.

9050 (76) Fine-grained black trap (diabase) showing augite, from dyke on road to Exeter Station, property of Samuel Manwiller, 1½ miles S. of Jacksonwald, Exeter township.

9051 (77) Compact specular? iron-ore, semi-magnetic, loose, from old opening on Squire Samuel Hile's farm 1 mile N. E. of Clayton, Hereford township.

9052 (78) Feldspathic syenite, "country rock" from mine on property of D. Cummener, 1 mile N. W. of Bechtelsville, Washington township.

9053 (79) Fine-grained, ferruginous gneiss, with minute crystals wine-colored quartz, from same locality.

9054 (80) Fine-grained, grey syenite, "hanging rock," Landis mine, Barto station, Colebrookdale R. R., Washington township.
9055 (81) Coarse hornblendic syenite, with crystals of iron pyrite, "foot rock" showing slickenslides, from same locality.
9056 (82) Decomposed granite, nodules of pink feldspar, loose, at roadside ½ mile S. W. of Union hotel, Bechtelsville, Washington township.
9057 (83) Ditto.
9058 (84) Pink orthoclase feldspar gneiss with some little quartz, 1½ miles N. E. of Spangsville, Earle township.
9059 (85) Rotten limestone, greatly decomposed, greenish grey, "top rock" upper Phœnix Slope, Boyertown, Colebrookdale township.
9060 (86) Altered syenite, carrying magnetic iron ore; feldspar greatly decomposed. "Foot wall" middle slope (No. 2) Phœnix mine, Boyertown, Colebrookdale township.
9061 (87) Rotten limestone, with coating of calcite. "Bottom rock" 1st level, ditto.
9062 (88) Impure limestone and calcite, "ore rock" lower level from ditto.
9063 (89) Chlorite rock, with grains of magnetic iron ore. "Foot wall" middle level, 143 ft. from shaft, Warwick mine, Boyertown, Colebrookdale township.
9064 (90) Magnetite with iron pyrites, in hornblendic syenite, from old opening on property of Andrew Schultz, ⅛ mile west of Treichlersville, Hereford township.
9065 (91) Micaceous gneiss, occurring on Emaus pike, just S. of Lehigh county line, ditto.
9066 (92) Grey magnesian limestone, from D. Benfield's quarry, at Hampton furnace, 2 miles E. S. E. of Siesholtsville, Hereford township.
9067 (93) Ditto; from James & Lewis Christman's quarry, ditto.

9068 (94) Chlorite rock, showing pyroxene, stilbite, and pyrite; from Colebrookdale RR. cut, below Wren's mill, Colebrookdale township.

9069 (95) Chlorite rock (greenstone) with pyroxene and olivine, from S. end of Colebrookdale RR. cut, above Wren's mill, ditto.

9070 (96) Ditto, with excess of feldspar. N. end of same cut, ditto.

9071 (97) Ditto, laminated and slightly decomposed. S. end of Colebrookdale RR. cut, above Mory's mill, from ditto.

9072 (98) Hornblendic syenite, showing large masses of pyroxene and slickensides. "Foot wall" Stouffer's mine, ½ mile N. of Bechtelsville, Washington township.

9073 (99) Ditto. N. end of cut above first trestling, S. W. of Gabel's mine, Colebrookdale township.

9074 (100) Bluish-gray chlorite rock, banded, from cut, just N. of Colebrookdale Station, Douglass township.

9075 (101) Syenite, with small crystals of pyroxene and feldspar. "Top rock" Gilbert's mine, 1½ miles N. of Bechtelsville, Washington township.

9076 (102) Indurated Mesozoic Sandstone, Colebrookdale RR. cut, opposite Colebrookdale Iron Works, Douglass township.

9077 (103) Ditto, hard and compact, from ditto.

9078 (104) Ditto. Side cut of Colebrookdale RR., about 700 ft. N. E. of same Iron Works.

9079 (105) Grey, compact, altered Mesozoic sandstone, just S. of dam of Colebrookdale Iron Works, in RR. cut.

9080 (106) Gneissic conglomerate, with small Potsdam quartzite pebbles, loose, S. slope of hill, ¼ mile W. of Eshbachville, Washington township.

9081 (107) Green stone, with nodules of feldspar and Zircon (?) crystals, from W. flank of Gabel hill, 1 mile S. W. of Boyertown, Colebrookdale township.

9082 (108) Indurated Mesozoic shale, greenish grey, from ditto.

9083 (109) Ditto. Near Weiman's mill, 1 mile S. of Greshville, Douglass township.

9084 (110) Pink, altered, Mesozoic sandstone, from road cut, near ditto.

9085 (111) Chlorite rock (greenstone) showing pyroxene and feldspar, between 1st and 2d levels Gabel mine, Boyertown, Colebrookdale township.

9086 (112) Magnetic iron ore, very hornblendic ,from Oberholtzer's mine, 1 mile N. E. Dale Forge, Hereford township.

9087 (113) Grey talcose slate, J. M. Bertolet's quarry, on little Manatawny creek, 1¼ miles S. E. of Friedensburg, Oley township.

9088 (114) Soft buff-colored slate, from ditto.

9089 (115) Dark-grey slate, from over limestones in Oberholtzer's quarry, ⅛ mile N. E. of Bechtelsville, Washington township.

9090 (116) Iron ore, brown hematite, botryoidal, from Udreé bank, 1¼ miles S. W. of Pricetown, Ruscombmanor township.

Lepidocrocite and bombshell brown hematite, with coating of manganese oxide, from ditto.

9091 (117) Brown hematite—bombshell ore—from Israel Heist's property, ¼ mile W. of New Jerusalem, Rockland township.

9092 (118) Brown hematite, from J. Fischer's ore holes, 1 mile W. of Green Hill tavern, Rockland township.

9093 (119) Ditto, in altered Mesozoic Shale, from small opening on property of H. Gilbert, 1 mile S. E. of Bechtelsville, Colebrookdale township.

9094 (120) Red hematite, from P. Brumbach's ore holes, ½ mile W. of Green Hill tavern, Rockland township.

9095 (121) Porous quartzose gneiss, with peacock coloring due to ferric oxide, from Oberholtzer's mine, 1 mile N. E. of Dale Forge, Hereford township.

9096 (122) White Potsdam S. S., "Silver Sand Rock," from summit of Sand Hill, 2 miles W. of Boyertown, Earl township.

9097 (123) Ditto, from quarry of J. Rhoades, on Reading road, ½ mile E. of Earlville, Earl township.

9098 (124) Potsdam quartzite, W. bank of Manatawny creek, property of D. Davidheiser, ¾ mile N. W. of Earlville, Earl township.

9099 (125) Reddish brown Potsdam quartzite, boulder, loose, at New Jerusalem, Rockland township.

9100 (126) Potsdam quartzite, coarse, from Shenkel's Hill, 1½ miles N. E. of Spangsville, Earl township.

9101 (127) Red and white Potsdam quartzite, coarse, Mengle Hill, 2 miles N. E. of Earlville, Earl township.

9102 (128) Purple quartzose conglomerate, (Potsdam S. S.,) from crest of Furnace Hill, 1½ miles S. E. of Pricetown, Ruscombmanor township.

9103 (129) Potsdam S. S.? gneissic conglomerate, loose, 1 mile N. E. of Shanesville, Pike township.

9104 (130) Soft white Potsdam S. S., vitreous, from pit on crest of Furnace Hill, 1½ miles S. E. of Pricetown, Ruscombmanor township.

9105 (131) Fine white sand, derived from specimen 130, ditto.

9106 (132) Coarse brown sand, from ditto.

9107 (133) Purple quartzose conglomerate, (Potsdam S. S.,) with nodules of pink feldspar and quartz crystals, from summit of Furnace Hill, near Oley Furnace, 1½ miles S. E. of Pricetown, Ruscombmanor township.

9108 (134) Blue magnesian limestone, D. Davidheiser's quarry, W. bank of Manatawny creek, ¾ mile N. of Earlville, Earl township.

9109 (135) Ditto, from W. bank of Manatawny creek, properties of M. Mengle and N. Gross, ½ mile N. of Earlville, Earl township.
9110 (136) Ditto, from F. Boyer's quarries, on Manatawny creek, 500 yards W. of ditto.
9111 (137) Ditto, with quartz veins, from F. Boyer's estate, upper quarry, ditto.
9112 (138) Ditto, from middle quarry.
9113 (139) Soft blue magnesian limestone, from M. Mengle's quarry, E. side of Manatawny creek, ½ mile N. of Earlville, Earl township.
9114 (140) Soft blue and grey limestone, D. M. Schollenberger's quarry, ½ mile N. of Pleasantville, Oley township.
9115 (141) Dark blue silicious township, with quartz veins, Wm. Y. Weidner's quarry, 1 mile S. of Lobachsville, Oley township.
9116 (142) Soft grey limestone, from ditto.
9117 (143) Blue magnesian limestone, from D. Davidheiser's quarry, ¾ mile N. of Earlville, Earl township.
9118 (144) Grey magnesian limestone, Davidheiser's quarry, ¼ mile S. W. of Greshville, Douglass township.
9119 (145) Grey limestone, very silicious, from H. Geist's quarry, ½ mile S. W. of Bechtelsville, Washington township.
9120 (146) Hard blue limestone, Davidheiser's quarry, ¼ mile S. W. of Greshville, Douglass township.
9121 (147) Grey cherty limestone, E. end of Oberholtzer's quarry, ⅛ mile N. E. of Bechtelsville, Washington township.
9122 (148) Hard blue limestone, from S. end of ditto.
9123 (149) Blue Quartzose limestone, with nodules of feldspar, from H. Geist's quarry, ¼ mile S. W. of Bechtelsville, Washington township.
9124 (150) Blue limestone, from Levi Gresh's quarry, ¼ mile N. E. of Greshville, Douglass township.
9125 (151) Blue limestone, from Davidheiser's quarry, ¾ mile S. W. of Greshville, Douglass township.

9126 (152) Dark blue magnesian limestone, Henry Keely's quarry, ⅝ mile S. W. of Greshville, Douglass township.

9127 (153) Grey limestone, N. end of Oberholtzer's quarry, ⅛ mile N. E. of Bechtelsville, Washington township.

9128 (154) Blue and grey limestone, from bottom and E. end of ditto.

9129 (155) Granular limestone, with pyroxene and garnets? loose from hill 1 mile N. of Bechtelsville, Washington township.

9130 (156) Blue limestone, quarry of D. F. Bertolet, 1½ miles W. of Pleasantville, on Little Manatawny creek, Oley township.

9131 (157) Ditto—I. Kauffman's quarry, 1½ miles N. of Griesermersville, Oley township.

9132 (158) Ditto—from E. Levan's quarry, (Deisher's quarry) 2 miles E. of Friedensburg, Oley township.

9133 (159) Blue limestone, J. G. Bertolet's quarry, Little Manatawny creek, 1½ miles S. E. of Friedensburg, Oley township.

9134 (160) Soft blue limestone, E. Wilman's quarry, ½ mile N. W. of Pleasantville, Oley township.

9135 (161) Soft dark blue limestone, E. end of D. Yoder's quarry, ½ mile N. E. of ditto.

9136 (162) Ditto—center of D. Kemmerer's quarry, at kiln, 2 miles S. of Friedensburg, Oley township.

9137 (163) Blue and grey massive limestone, E. Wilman's quarry, ½ mile N. W. of Pleasantville, Oley township.

9138 (164) Blue limestone, N. end of D. Yoder's quarry, ½ mile N. E of ditto.

9139 (165) Ditto—with calcite, W. end of same quarry.

9140 (166) Dark blue impure limestone, occurring between beds of magnetic iron-ore, Gabel mine, Boyertown, Colebrookdale township.

9141 (167) Greenish grey bastard limestone, with calcite and feldspar, Warwick shaft, Boyertown, ditto.

9142 (168) Ditto—occurring between ore and foot wall, from upper slope No. 1, Phœnix mine, Boyertown.

9143 (169) Impure slaty limestone, with iron pyrite, "top rock," ditto.

9144 (170) Impure greenish grey limestone, above first level, Gabel mine, ditto.

9145 (171) Calcite, accompanying ore, Warwick mine, ditto.

9146 (172) Graphite—in quartz and decomposed white feldspar, near house of J. Bechtel, 1 mile W. of Boyertown, ditto.

9147 (173) Cores of Mesozoic conglomerate, from boring of Diamond Drill Co., Warwick shaft, Boyertown, ditto.

9148 (174) Graphite in micaceous gneiss, decomposed, near house of J. Bechtel, 1 mile W. of Boyertown, ditto.

9149 (175) Graphitic gneiss—Dr. Funk's fish-pond ½ mile west of Boyertown, ditto.

9150 (176) Graphite in quartz and micaceous gneiss, near house of J. Bechtel, 1 mile W. of Boyertown, ditto.

9151 (177) Mesozoic conglomerate—from Manatawny creek, 1 mile S. E. of Earlville, Amity township.

9152 (178) Ditto—top covering, Warwick mine, Boyertown.

9153 (179) Greyish blue Potsdam S.S. partly decomposed, from hill N. of Reading road, 1 mile S. W. of Greshville, Douglass township.

9154 (180) Compact white Potsdam S. S. loose, on summit of hill ¼ mile W. of Eshbachville, Washington township.

9155 (181) Potsdam S. S. with highly decomposed feldspar, exposing pink and colorless quartz crystals, from W. end of F. Stauffer's quarry, on small hill, N. of Mt. Pleasant Seminary, Boyertown, Colebrookdale township.

9156 (182) Ditto; from 2d quarry further east, ditto.

9157 (183) Feldspathic clay, resulting from decomposition of above, from cellar Mt. Pleasant Seminary, Boyertown, ditto.

9158 (184) Potsdam SS. with coarse quartz crystals, from F. Stauffer's west quarry, ditto.

9159 (185) Ditto ; brown, partially decomposed, from John W. Rhoades' quarry, ¾ miles E. of Earlville, Amity township.

9160 (186) Potsdam quartzite, pink quartz crystals, from outcrop on hill 1 mile S. W. Hill Church, Earl township.

9161 (187) Potsdam SS., dull white, vitreous, Naugle's hill, 1½ miles N. E. of Earlville, Earl township.

9162 (188) Ditto, bluish grey, compact, from Powder Mill valley, 1½ miles N. E. of ditto.

9163 (189) Ditto, 300 ft. S. W. from specimen 188, ditto.

9164 (190) Ditto, from ridge of Mengle's hill, 2 miles N. E. of ditto.

9165 (191) Potsdam quartzite, with *Scolithus* borings, from summit of hill ¼ mile west of Eshbachville, Washington township.

9166 (192) Magnetic iron ore, ("Black ore") with iron pyrites, top level Warwick mine, Boyertown, Colebrookdale township.

9167 (193) Ditto, (black ore) lower level, at shaft, ditto.

9168 (194) Magnetic iron ore, interstratified with impure limestone, and showing clusters of iron pyrites, Gabel mine, ditto.

9169 (195) Ditto, (black ore) from upper slope No. 1, Phœnix mine, Boyertown, ditto.

9170 (196) Ditto, (black ore) with limestone and iron pyrites, S. of shaft upper level, Warwick mine, ditto.

9171 (197) Ditto, (black ore) with incrustation of calcite and iron pyrites, Warwick mine, ditto.

9172 (198) Magnetic iron ore (black ore), middle level, showing calcite and iron pyrites, "Warwick Trespass," Gabel mine, ditto.

9173 (199) Ditto, No. 1 black ore, crystallized, Warwick mine, ditto.

9174 (200) Magnetic iron ore, in limestone, Phœnix middle slope, Boyertown, ditto.

9175 (201) Magnetic iron ("blue ore"), lean, Gabel mine, Boyertown, ditto.

9176 (202) Ditto, (black ore,) lean, showing calcite and iron pyrites, from 567′ lower level, Warwick mine, ditto.

9177 (203) No. 1 black magnetic iron ore, Phœnix upper slope, Boyertown, ditto.

9178 (204) Magnetic iron ore, face of gangway 300 ft., north of slope, Phœnix middle slope, ditto.

9179 (205) Ditto, with pyrite and coating of calcite, from slip, middle slope Phœnix mine, ditto.

9180 (206) Ditto, 2d bench (blue ore) showing iron pyrites, Gabel mine, Boyertown, ditto.

9181 (207) Ditto, (black ore mixed with calcite), from underneath Mesozoic conglomerate, ditto.

9182 (208) Magnetic iron ore (blue ore) from 2d (464′) level, Gabel mine, Boyertown, ditto.

9183 (209) Ditto, hard, close-grained and black, with little iron pyrites, from 216′ level, Landis mine, Barto Station, Washington township.

9184 (210) Crystallized black magnetic iron ore, open structure, lump ore, from Clymer & Co.'s open cut on S. flank of Furnace hill, 1½ miles S. E. of Pricetown, Ruscombmanor township.

9185 (211) Magnetic iron ore, tough, black, titaniferous, and with wine-colored crystals of zircon, loose, on dump of Schittler's mine, 1½ miles east of Pricetown, Ruscombmanor township.

9186 (212) Ditto, from same mine.

9187 (213) Fine ore, manganiferous, from same mine as specimen No. 210.

9188 (214) Magnetic iron ore, very hornblendic, from Oberholtzer's shaft, ½ mile N. E. of Hill church, Pike township.

9189 (215) Ditto, tough, with large crystals of feldspar, from Gilbert's mine, 2 miles N. from Bechtelsville, Washington township.

9190 (216) Soft ore, semi-hematite, from over magnetic iron ore, in Bittenbender's shaft, ½ mile N. E. from Siesholtzville, Hereford township.

9191 (217) Magnetic iron ore, greyish blue, largely mixed with limestone and feldspar, "Hard Ore," from bottom of same shaft, ditto.

9192 (218) Ditto, in decomposed gneiss, loose, in George Rohrbach's field, Huff's church, Hereford township.

9193 (219) Magnetic iron ore, (soft ore,) with considerable mica, from Hertzel's & Swoyer mine, 1¼ miles N. E. of Friedensburg, Oley township.

9194 (220) Specular iron ore, with stalactitic crystallization, old opening of Kaufman & Spang, at base of Furnace Hill, 1¼ miles E. of Spangsville, Earl township.

9195 (221) Potsdam S. S., from quarry at "White Spot," on crest of Mt. Penn, 1 mile east of Reading depot, Alsace township.

9196 (222) Light blue compact magnesian limestone, from Jacob Christman's quarry, near Hampton Furnace, Hereford township.

9197 (223) Grey magnesian limestone, Jonas Shaub's quarry, ditto.

9198 (224) Light grey and pink gneiss, "foot wall," Tunnel Mine, Rittenhouse Gap, Longswamp township.

9199 (225) Quartzose feldspathic gneiss, "hanging rock," ditto.

9200 (226) Black micaceous gneiss, from immediately under ore, ditto.

9201 (227) Magnetic iron ore, in gangue of white feldspar, frequently found as a "horse" in foot wall of syenite, Tunnel Mine, Rittenhouse Gap, Longswamp township.

9202 (228) Green decomposed slate rock, from dyke in Tunnel Mine; ditto.

9203 (229) Stratified, granitoid gneiss, with scales of black mica, Thomas Iron Co. open cut, Rittenhouse Gap, ditto.

9204 (230) Blue limestone, J. Rush's quarry, ½ mile N. W. of Dale Forge, Hereford township.

9205 (231) Banded gneiss, blue coating of silicate of alumina and magnesia, colored with iron, (FeO,) loose, on road near J. Dotterer's house, ½ mile E. of Hill Church, Pike township.

9206 (232) Conglomeritic rock, (Potsdam S. S. ?) with large quartz nodules, from summit of small hill, S. of J. Hess' house, 1 mile N. W. of Hill Church, Pike township.

9207 (233) Magnetic iron ore, from same place as specimen No. 215.

9208 (234) Ditto, same character as No. 233, from Gilberg's Mine, property of E. Nestor, 1½ miles N. W. of Barto, Washington township.

9209 (235) Ditto, in hornblendic (pyroxene ?) syenite, from Sparr's Mine, 2 miles N. W. of Churchville, Washington township.

9210 (236) Trap, with hornblende and felsite, decomposed, from outcrop on hill S. E. from Bechtelsville 1 mile, near Stauffer's saw mill, Washington township.

9211 (237) Specular iron ore ? (argillaceous Potsdam slates impregnated with iron) from Dotterer's "Red Oxide" mine, on crest of Saw Mill Hill, 1 mile E. of Pleasantville, Earl township.

9212 (238) Quartz conglomerate, (Potsdam ?) showing large pink quartz crystals, from ditto.

9213 (239) Blue limestone, from J. Keim's quarry, at foot of Angstadt hill, 1 mile west of Lobachsville, Oley township.

9214 (240) Ditto—from same hill, Keim's No. 2 quarry.

9215 (241) Dark greenish black slate, loose, from ore hole on Clymer & Co. property, overlying soft magnetic iron ore, 1½ miles S. E. of Pricetown, Ruscombmanor township.

9216 (242) Magnetic iron ore (lump) highly charged with mica and slate, from same place as specimen 241.

9217 (243) Blue limestone and calcite, from Peter Rapp's quarry, 200 yards S. of Reading road and 2 miles E. of Earlville, Amity township.

9218 (244) Pyroxenic chlorite rock, with blue coating of silicate of alumina and magnesia, from cross-cut near Warwick trespass 460′ level, Gable mine, Boyertown, Colebrookdale township.

9219 (245) Chlorite rock, showing pyroxene, foot wall at shaft, below blue ore bed, Gabel mine, ditto.

9220 (246) Blue limestone, massive, from N. Fryermuth's quarry, 2 miles E. of Earlville, Amity township.

9221 (247) Decomposed feldspathic rock, with quartz crystals and serpentine, from N. bank of Manatawny creek, 500 yards S. W. of Earlville, ditto.

9222 (248) Blue and white limestone, from M. Diehl's quarry, ¼ mile S. W. of Clayton, Washington township.

9223 (249) Grey and white limestone from A. G. Clemmer's quarry, ¼ mile N. E. of Clayton, Hereford township.

9224 (250) Red hematite (specular ore) Shimersville mine, ⅛ mile N. E. from Shimersville, *Lehigh co.*

9225 (251) Blue limestone, D. H. Schall's quarry, S. of dam at Dale Forge, Washington township.

9226 (252) White limestone, D. H. Schall's quarry, 300 yards N. of Dale Forge P. O., Hereford township.

9227 (253) Magnetic iron-ore, Barto mine, at Barto station, Washington township.

9228 (254) Mesozoic conglomerate (calcareous) hanging rock No. 1 slope, Fritz Island mine, 2 miles S. of Reading, Cumru township.

9229 (255) Mesozoic conglomerate, from hill summit 1 mile S. E. from Shultzville, Washington township.

9230 (256) Trap rock (dolerite) dividing ore in No. 1 and 2 slopes, Fritz Island mine, 2 miles S. of Reading, Cumru township.

9231 (257) Magnetic iron ore, in gneiss, Thomas Iron Co.'s open cut, Rittenhouse property, Longswamp township.

9232 (258) No. 1 magnetic iron ore, from No. 1 slope, Fritz Island mine, 2 miles S. of Reading, Cumru township.

9233 (259) Average magnetic iron ore, showing calcite, from same locality.

9234 (260) Muscovite mica, loose on road at east base of Shenkel's hill, Earl township, 1 mile N. E. Spangsville.

9235 (261) Green muscovite mica, loose at dump, Clymer magnetic ore mine, 1½ mile S. E. Pricetown, Ruscombmanor township.

9236 (262) Green mica, Kemp farm, ½ mile south Huff church, Hereford township.

9237 (263) Drusy quartz colored with ferric oxide, and jasper, from Flint hill, Rockland township, 1 mile south Bowers' Station.

9238 (264) Green serpentine, carrying magnetite and pyrite, Island mine, 1½ miles south Reading.

9239 (265) Magnetite with coating of hematite, "Hagy vein," Lower Phœnix slope, Boyertown.

9240 (266) Chabazite, Island mine, 1½ miles south Reading.

9241 (267) Pink serpentine, ditto.

9242 (268) Pink calcite, Leinbach's hill, 1½ miles west Reading.

9243 (269) Bornite, chalcopyrite, and pink calcite, on altered New Red shale, Island mine.

9244 (270) Serpentine, dendrites, and datholite, ditto.

CHAPTER XII.

List of the Minerals of Berks county with their localities.

In the compilation of this table I am especially indebted to Mr. H. W. Hollenbush and Dr. D. B. Brunner of Reading, not only for permission to inspect their beautiful cabinets, but for a very full statement of the specimens and localities known to them. This statement I have supplemented by quotations from Dr. F. A. Genth's report *B*,

(1875), and by my own observations during four years of my connection with Survey.

The list is necessarily incomplete for Berks county as a whole, but will fairly well represent the mineralogy of its South Mountain belt.

Table of Minerals.

Allanite.—Found on the Haines', Rhoades', and Schroeder's farms, Pricetown, Ruscombmanor township, associated with magnetite and zircon.

Allophane.—Jones mine, Caernarvon township, in fine white and sky-blue mammillary and stalactitic masses.

Apatite.—Jones mine, sparingly, of a bluish color, with magnetite; also at Mt. Penn Iron mines, (Rogers, page 716, Vol. II.)

Apophyllite.—Fritz Island mine, Reading, associated with calcite and several zeolites, occurring in at least three varieties of tetragonal crystals.

Aragonite.—Jones mine, in acicular crystallizations and botryoidal and fibrous coatings; sparingly at Fritz Island mine; Virginsville, at Crystal cave, abundantly in small crystals and fibrous stalactites; recently found at Wheatfield mines and Ruth mine.

Amphibole.—(Hornblende rock,) occurring in many places throughout the county, but as the variety *Actinolite*, at Jones mine; as *Asbestos*, at Earlville on the Manatawny, and at Ohlinger dam, Alsace township; as *Mountain Leather*, at Boyertown, Colebrookdale township, and as *Hornblende*, a constituent of many of the South Mountain rocks; beautifully at Ohlinger's dam; Henry Ruth's farm at Mohrsville, in Cumru township; as *Byssolite*, at Ohlinger dam and in Longswamp township; Boyertown.

Aurichalcite.—Reported as found at Jones mine, Cærnarvon township, and at Fritz island.

Azurite.—Fine crystallizations were found some years ago at Jones mine; occurs also crystallized and massive at Fritz island.

Barite.—Prof. Genth mentions the occurrence of a fetid Barite, in brownish, radiating and columnar ferruginous masses in Heidelberg township; also at Mt. Ætna, in Tulpehocken township.

Bornite.—Jones mine, and good specimens at Fritz Island mine.

Brucite.—(Rare.) Fritz Island mine.

Calcite.—Various forms have been met with in greater or less quantity at the Crystal Cave, Virginsville. Manganese dendrites occur on calcite on Fritz island; *Dogtooth Spar* occurs at Fritz island; in Luckenbill's cave, Perry township; and at Big dam, on the Schuylkill. Fine large rhombohedra, pink crystals occur about 1 mile north of Reading; also pink calcite in bluish quartz on Leinbach's hill, west of Reading, and at Hartzog's mill, Exeter township; specimens of a pale pink or rose color, consisting of small flat rhombohedra, yielded on analysis 13.28 per cent. carbonate of manganese, from DeTurk's farm 4 miles east of Reading, in Exeter township; also at Boyertown; Greenwich township; Jones mine, Siesholtzville, Shellington, Wernersville, and Wheatfield mine, and in various places in the East Penn-Lebanon valley.

Calc. Spar.—Bern township and Cumru township.

Chalcocite.—Occurs sparingly in granular and compact masses at Jones mine and Fritz island.

Chalcopyrite.—Jones mine and Fritz island, associated with magnetite.

Chlorite.—Fritz island, Boyertown, Raudenbush mine, Clymer Tunnel mine, Wheatfield mine, Ruth mine.

Chrysocalla.—Sparingly at Fritz island; also at Jones mine where several fine but small fragments were obtained some years ago.

Chrysolite.—Fritz island; Wheatfield mine.

Copper.—This metal has been found native in both crystalized and arborescent forms at Jones mine. Some fine specimens taken out in 1859, covered in some places with cuprite, giving them a dull color. *Melaconite* (CuO) has also been found here, as well as a sea-green

clay carrying 2.5 to 10 per cent. copper. *Cuprite* is very rare, none having been found at the Jones mine since 1860. Also sparingly at Boyertown.

Damourite.—Jacob Fox's farm, Ruscombmanor township; at Rockland forges, of a yellowish pale green color, with a pearly luster found in masses with a lilac quartz; Levi Merkle farm, Oley township; Wheatfield mine, and in the various limonite mines in the limestone valley. Mr. Hollenbush has some fine specimens which he classes under the variety *sericite.*

Datolite.—Fritz Island, in good crystals.

Dendrites.—Fritz Island in limestone.

Deweylite.—Ruth Mine.

Epidote. — Ohlinger Dam; Boyertown; Fleetwood; Schmeck's farm, Longswamp township; Hancock and Wetzel farm, Longswamp township; Pricetown; in small crystals on feldspar one mile east of Reading and abundantly in the South Mountains in greenish-yellow crystals and granular masses, as one of the products of the alteration of pyroxene rocks. Haines farm, and W. Hartman's farm.

Fayalite.—Found as a furnace product at the Reading Sheet Mill; also in nature 1½ miles N. E. Boyertown, at Fegley's farm.

Feldspar Group.—Forming the principal constituent of the South Mountain rocks, containing also a variety of pyroxene.

Labradorite, in the various trap rocks, and possibly at Ohlinger Dam; *Oligoclase* or *Albite*, at Nestor and Gilbert Mines, with magnetite, Washington township; at Siesholtzville; in the trap south of Jacksonwald in Exeter, and along the Schuylkill at the Little Dam; at Hill church; *Orthoclase*, typical, at Ohlinger Dam; on the eastern slope of Mount Penn; Huff Church, and elsewhere; *Red Orthoclase*, and other feldspar minerals, at Ohlinger's Mill, 6 m. E. Reading.

Fluorite.—Fritztown, as pale, topaz-colored modified cubes, measuring ⅛ to ⅜ of an inch in diameter, associated with calcite. Smaller crystals of an amethystine hue

are found in Brook's quarry, north of Reading; granular masses and crystals of violet and purple tints occur sparingly in DeTurk's quarry, Exeter township; of a purple color on Leinbach's hill; at Big Dam on the Schuylkill; Wheatfield, in amber colored crystals; also at Fritz Island Mine.

Galenite.—Fritz Island, sparingly, in granular masses.

Garnet.—W. Hartman's farm, Alsace township, in brown crystals; V. Hartman's farm; Fritz Island as *Grossularite*, (lime-alumina-garnet,) in grayish green crystals; Bishop's (Hartzog?) Mill in twin crystals, Exeter township; Haines' farm, near Pricetown; Rhoades farm and Schroeder's farm, in Ruscombmanor township; Gottschall Mine, Alsace township; Spies Church, Alsace, in small reddish-brown and wine color crystals, probably *andradite*, and as *spessartite* at V. Hartman's farm; also at Eshbachville.

Gold.—One locality is thus far reported in Berks county, where native gold is said to exist, viz: at the western base of Mt. Penn, near the suburb of Hampden. The late John P. Miller found a piece of quartz bearing traces of this metal, with one or two very prominent particles. Dr. Charles M. Wetherill found traces of gold in ferruginous quartz from the same place, an extended discussion of which will be found in the *Trans. Am. Philos. Soc.*, Vol. X., p. 350, *et seq.*

Göthite.—At Udrée Mine, 1½ miles south of Pricetown, as well as the variety *lepidocrocite.* Mr. Hollenbush has also found the so-called velvet ore at Sinking Springs, and in some of the mines in the East Penn valley; lepidocrocite at P. D. Wanner's farm, Alsace, and at head of Walnut street, Reading; Moselem.

Graphite.—Jones mine sparingly and 2 miles north-east holding 10.85 per cent. of carbon; in yellow jasper at Kinzi mine, Stony creek; at Boyertown on farms of Fegeley 1½ miles N. E.; at J. Bechtel and Daniel Himmelreich farms and at Dr. Funk's fish-pond, all in Colebrookdale township; Schmeck's farm Longswamp; in magnetite at Siesholtzville.

Gypsum.—Jones mine (rare) in acicular crystals; Bushong's mine in crystals 1½ in. long, and at Boyertown.

Hematite.—(Specular.) See list of mines in Chap. IX.

The micaceous and specular varieties both occur to a limited extent at Fritz island; Lobachsville massive; Dumm's mine.

Kämmererite.—Wheatfield mine.

Kaolin.—Fleetwood, James F. Dumm's mine; Kemp farm, (Hunter mine,) Oley township; Schmeck's farm 1½ miles south Mertztown, Longswamp township; Boyertown; Mt. Penn; often as specks in Potsdam S. S.; sand pit on Furnace hill, near Clymer iron mine.

Limonite.—See list of mines in Chap. X.

Jacob Fox's farm, Ruscombmanor township; S. Slegel's farm near Lancaster bridge west of Reading, in botryoidal shapes and also in dentritic forms, branched like corals, and as bog ore and pseudomorphs after pyrite; north Reading; Flint hill; Wheatfield mine; Fritz island, etc.

Magnetite.—See list of mines in Chap. VIII of this report.

Crystallized in fine octohedrons and dodecahedrons at Boyertown, Fritz island and occasionally at Jones mine; as *titaniferous magnetite* near Treichlersville, Hereford; at Pricetown, and at Huff church, Hereford; massive at Jacob Fox farm.

Magnesite.—Kaufman & Spang specular iron-ore mine, near Spangsville, Earl township.

Malachite.—Very fine pieces were obtained from Jones mine some years ago. The general form was in botryoidal masses and fibrous. It admitted of a very high polish; Fritz island fibrous, in radiating forms and botryoidal coatings.

Marble.—Leesport, Ontelaunee township; Shillington, at Hill's quarry, Cumru township; Topton, flesh colored · Wernersville.

Marcarsite.—Fritz island, (doubtful,); Leesport?

Mica Group.—Disseminated to some extent throughout the South Mountain range and occurring in the "soft magnetites" along the south flank of Furnace hill, in Rus-

combmanor and Oley and at Siesholtzville and Spangsville; variety *muscovite*, near Huff church in rhombohedral crystals, and at Ohlinger dam; Oley Tunnel mine, Clymer magnetic iron mine and elsewhere.

Biotite or black mica near Huff church, and along road to Stony Point about 1 mile N. E. Pricetown.

Molybdenite.—Valentine Hartman's farm, Alsace, in crystallized and foliated masses; at Zion's church; Ohlinger dam, Alsace; Flint hill, Rockland township.

Ochre.—Jacob Fox's farm, where it was formerly used in an old paint mill; Noll's mine, Fleetwood; Udrée mine, red and yellow varieties; Siesholtzville red; Flint hill, Rockland.

Prochlorite.—Associated with magnetic iron ores at Siesholtzville, Topton, and Wheatfield mines, and various mines in the South Mountains; in curved hexagonal crystals at Fritztown.

Psilomelane.—Fine specimens from near old Rockland forges, and frequently associated with limonite in the mines of the valley.

Pyrite.—Associated with many of the iron ores of the county, too numerous to mention; at Fritz Island in crystals and massive; in beautiful octohedra at the Boyertown mines; at Wheatfield mines; Siesholtzville; globular and radiating at Virginsville; in radiating crystals in Windsor Twp.; nodular variety in Center township.

Pyroxene.—Gottschall's mine, Alsace township, in large cleavage masses from ¾ of an inch to nearly 2 inches across and 2 to 3 inches long, dark-greenish black in color and with sometimes a sub-metallic luster; at Ohlinger dam; beautiful crystals at Rauch's mine, Hereford township; at Eshbachville; Raudenbush mine; Sparr's mine, in Washington township; Colebrookdale R. R. cuts south of Boyertown; as the variety *Sahlite*, a frequent constituent of the South Mountain syenites, and at Siesholtzville; *Augite* at Babb's Tavern and Ohlinger dam, and in many of the trap rocks of the county; at Ohlinger mill, 6 miles E. Reading.

Pyrrhotite.—At Gottschall's mine, Alsace township, slightly nickeliferous; Boyertown; Ohlinger dam; Raudenbush mine.

Pyrolusite.—Dr. Genth mentions this mineral as occurring "in small rhombic crystals in geodes, frequently associated with turgite, in limonite beds" in the county, but refers to no special localities.

Quartz.—Pure transparent crystals occur from ½ to 2 inches in length at Lee's farm, 1 mile S. E. of Friedensburg, Oley township; smaller crystals in the Crystal cave, Virginsville; doubly terminated crystals at Noll's mine, Fleetwood; in Windsor township; Fritz Island. The *smoky* variety has been found crystallized on Updegroff's farm, Union township; in Windsor township, and on the Boyertown road 4 miles east of Reading. *Blue* (amethystine) quartz, massive, though of good colors, in Oley township; Jacob Fox farm.

Ferruginous quartz in small brownish yellow crystals in Rockland township; also on Bomegratz's farm in Ruscombmanor.

Drusy quartz, occasionally tinted milky, pale blue, pink, and ferruginous at Flint hill, Rockland township, in profusion; coating limonite in many of the valley mines; on Bomegratz's farm, 2 miles west Pricetown.

Chalcedony frequently resulting from drusy quartz, and therefore found at many of the above localities; beautifully at Flint hill, where it takes a high polish; at Fleetwood; Fritz Island; on the Oley-Hamburg road near Friedensburg;. Wernersville; Bomegratz's farm, in globules, etc.

Chalcedonic Jasper and *Jasper*, at Flint hill; Haines', Rhoades', and Schroeder's farms, in Ruscombmanor; Longswamp township, near Mertztown; Kinzi mill, in Exeter; Cushion Mt., Wernersville; Fleetwood; Reading; Greenwich township.

Lilac quartz, Leinbach Hill and Rockland forges.

Agate and *Agate-Jasper*, grading into several other varieties, as *Hornstone*, *Flint*, *Floatstone*, *Basanite*—at Boyertown, Fleetwood, Flint hill, Friedensburg; the

latter at Kutztown; yellow jasper at Gottschall's mine; Longswamp; Pricetown loadstone; Jacob Fox farm, cellular quartz, Lydian stone, red jasper, flints in nodular forms, chalcedony; Oley-Hamburg road in Ruscombmanor, honey-colored flint, with a coating of a chalk-like mineral; Moselem, öolitic chalcedony.

Retinalite.—Fritz Island mine; Wheatfield mine; Ruth mine; Jones mine.

Ripidolite.—Fritz Island mine; Jones mine.

Rutile.—In threadlike inclusions in gneiss at Ohlinger dam (doubtful.)

Serpentine.—Magnificent specimens at Fritz Island, various colors, running through shades of yellowish-brown to dark-olive green; also *precious* or *noble* serpentine and soapstone at Topton, Longswamp township; and in Wheatfield mine, Boyertown, Ruth mine, Jones mine, (soapstone.)

Siderite.—V. Hartman's farm, Alsace township, (Genth,) and at Weaver mine, Oley township.

Silver.—Traces at North Reading.

Sphene.—In magnetite, 1½ miles south of Huff's church, Hereford township.

Stibnite.—Tersulphide of antimony—was found to occur in minute crystals at Fritz Island, near Reading, associated with zeolites.

Talc.—As steatite this has been found sparingly at Fritz island, and at Jones mine; Longswamp township at Topton.

Titanite.—2 miles N. E. from Jones mines.

Trap.—*a. Diabase*, at Babb's tavern on road to Ohlinger dam; at S. Manwiller's farm 1½ miles S. Jacksonwald, Exeter township; in Snyder's quarry, Oley Line.

b. Diorite, Jacob Fox farm; Little dam, Schuylkill river; D. Wentzel's farm, Oley township, in egg-shaped boulders. Ohlinger's mill 6 miles east of Reading.

c. Basalt, on Tulpehocken creek, 2 miles north-west of Reading, and generally occurring in some form in the various magnetic iron-ore mines bordering the Mesozoic sandstone formation.

Turgite.—Occurs in thin layers on limonite at the Udrée mine, occasionally showing lustrous tints and at times iridescent; at Moselem; on Mount Penn, at P. D. Wanner's farm.

Venerite.—Jones mine.

Wad.—(Earthy oxide of manganese) in mamillary concretions near the Morgantown road, about ¼ mile below Lancaster bridge; Lyons; massive specimens in the old Oley tunnel mine; globular near Birdsboro. Also as a frequent associate of the limonite ores; Nathan Althouse farm, Maiden creek.

Wavellite.—Wheatfield mine.

Wernerite.—Crystals ½ inch in length with resinous luster are found at Fritz island.

Williamsite.—Wheatfield mine.

Xanthite.—Fritz island mine.

Xanthosiderite.—Flint Hill; Pricetown; Lyons.

Zircon.—Fine crystals have been found associated with magnetite on Haines, Rhoades and Schrœder's farm, Pricetown; near Barnhart's dam. The Pricetown zircon is of a deep wine color in crystals from ½ to 1½ inches in length.

Zeolite Family.—*a. Thomsonite*, at Fritz island in globular forms, and in concretions with radiating structure.

b. Mesolite, at Fritz island, in minute white tufts and fine white radiating needles—fibrous.

c. Chabazite, at Fritz island in beautiful colorless crystals.

d. Stilbite, at Ohlinger dam and Colebrookdale R. R. cut south of Boyertown, in radiating crystallized masses; Raudenbush mine, Cumru township; Fritz island; Jones mine; Wheatfield mine.

e. Undescribed Zeolite found at Fritz island, but not in sufficient abundance to yield accurate analysis for identification or classification. Observed specimens consist chiefly of small hollow shells, resulting from the weathering out of calcite crystals upon which the zeolite has been deposited.

APPENDIX TO REPORT D[3], VOL. II.

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*Indians of Berks County.**

Prior to the settlement of the county by the French Huguenots, in 1704-1710, under the land grant to Wm. Penn, New Jersey and a large part of Pennsylvania were inhabited by that tribe of Indians known as the *Delawares* or Lenni Lenape, *i. e.*, *original people.*

As they were the possessors of the country first occupied by Europeans, they were consequently the first dispossessed. Co-incident with the advances, or perhaps more appropriately the inroads of civilization, the Indian was obliged to relinquish his cherished haunts, though to the credit of Penn and his system of government, this change was less violent here in Pennsylvania than in other parts of the country.

In point of fact, the fraternity between white and aborigine in south-east Pennsylvania, brought about by generally just and equitable trade and payment, was very marked, and only the natural reserve of the Indian and his different habits banished him from a land where he was not excluded by any terms of purchase or agreement.

Moreover, his inherent savage nature unfitted him, without early training, to the manners and customs of his European brother, and it is not to be wondered at that, with the unlimited opportunity of the day to defraud and irritate that the trader enjoyed, he did occasionally give cause for that savage nature to loosen itself.

And so it is a matter of history that peace and harmony did not always reign through the Schuylkill Valley.

The special division of the Delaware Indians that were

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*Note.—Most of the material used in this sketch of the Berks county Indians is taken from Dr. D. B. Brunner's book, entitled "The Indians of Berks county." The figures have all been cut by Mr. Brunner himself, who kindly allows their reproduction in this report.

supposed to inhabit Berks county and the south-eastern part of Pennsylvania generally, were the *Minsi* or *Wolf tribe*, having their headquarters at Shamokin and Minisink.

It is furthermore a generally accepted fact that the Indians along the Manatawny (signifying *where we drink liquor*) and in Oley (signifying a *hollow amony the hills*, a name no doubt derived from its topographical features)—were a sub-division of the Wolf, with headquarters in Amity, which was the meeting place between the Indians and representatives of the Provincial Council of Philadelphia, and rather too distant from Shamokin to have permitted of much intercourse.

The settlements at Reading, Virginsville, and in Maxatawny, so well indicated by the profusion of Indian remains found at each, all had their chiefs, who were probably subordinate to the higher authority at Shamokin.

The earliest record mentioned of the Indians of Berks county is an interview which took place March 12, 1705, between a chief and John Evans, Lieutenant Govenor of Pennsylvania, to arrange for the transfer of the *Ganawese* or *Piscataway Indians* from the Potomac (where sickness had greatly reduced their number) to the more salubrious region of the Tulpehocken or *Land of Turtles*.

The banks of the Tulpehocken and Cacoosing or *place of owls*, became as important a centre for trading in the early years of white settlement, as it had formerly been a favorite hunting ground and Indian domain.

It was here that Conrad Weiser located about 1729, about a mile east of the present site of Womelsdorf.

He brought with him from New York a thorough knowledge of the Indian language, customs, and wants, which led to his appointment in 1732 as an agent and ambassador together with Shekallamy, his friend and the appointee of the Five Nations, who resided at Shamokin.

These two men—the former especially—wielded a powerful influence in their day. They were the ambassadors to the different tribes, the peacemakers when dissentions arose, and were universally respected for dignity of manners, wis-

dom in council, and conscientiousness in the administration of public affairs.

Three years after this, in 1732*, Sassoonan, the sachem of the Delaware Indians, sold to John, Thomas, and Richard Penn, all the land between the Lechay (Lehigh) hills or South Mountains and the North, Kittatinny or Blue Mountains, and between the Delaware and Susquehanna rivers.

This was practically the Great Limestone valley south of the North Mountain, and though the terms of the sale did not expel the aborigine from this territory, the country was so rapidly overrun by the white settlers, that the privacy of their villages and council fires compelled them to remove beyond the mountains, so that this date really left the Berks county of to-day free from Indian domain.

The first real break in this peaceful and harmonious method of settlement by purchase, occurred at the breaking out of the French and Indian war in 1754. All the native barbarity of the savage was let loose on the English settlers who were arrayed against the French and Indians. These hostilities led to the erection of numerous forts along the frontiers of civilization from the Delaware to the Susquehanna at a distance of about 12 miles apart. As very few settlements had been made beyond the North Mountain, these forts were built to the south of that range, and were intended as places of refuge to which the people might flee in times of danger. They failed of their purpose owing to the Indian mode of warfare of attacking only defenseless houses and falling upon unsuspecting men and women as they were engaged in tilling the soil.

The chief among these forts in Berks county were: *Fort Henry* or *Dietrich Six's* in Bethel township, three miles north of Millersburg and about 50 yards distant from the old Shamokin road that leads over the mountain.

Fort Northkill, situated on the stream of that name, in Upper Tulpehocken township, about two (2) miles east of Strausstown.

Fort Lebanon, "on the forks of the Schuylkill," prob-

*Others have recorded this date as 1736.

ably near Port Clinton, at the fork of the Little Schuylkill, afterwards called Fort William.

Fort Franklin, at that time (1756) in Berks, now in Schuylkill, on Lizard creek a few miles beyond (north of) Albany township line.

The largest of these, Fort Lebanon, is thus described:* "Fort Lebanon, about 24 miles from Gnadenhutten in the line to Shamokin. Fort 100 feet square. Stockades 14 feet high. House within built 30 by 20, with a large storeroom. A spring within. A magazine 12 feet square. On a barren, not much timber on it. One hundred families protected by it within the new purchase. No township. Built in 3 weeks; something considerable given by the neighbors towards it."

The defeat of the English under Braddock, in 1755, at the commencement of the war, greatly elated the French and Indians, and threw open the whole tier of northwestern townships of Berks county to the depredations of the savages.

From that time till 1763, dreadful massacres and every conceivable atrocities were committed upon the inhabitants of this county, and the Pennsylvania Archives and Colonial records are full of the most heart-rending murders and outrages.

Indian Villages.

As the Indians had no literature and but little education, no written records of their settlements could be expected.

Some of the implements that are found at the present day and the rocks in places where they lived, bear some hieroglyphics which undoubtedly had their significance, but as every Indian chief had an individual signature, these characters become mere synonyms for the *personnel* of the signer.

The Pennsylvania archives give 112 of these characters which the Indian chiefs attached to deeds.

It is in the unwritten history of these races—the relics

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* Pennsylvania Archives, Vol. 2, p. 665.

and remains of the rude utensils and implements—that we have to look for some idea of their craft and handiwork, and the profusion in which they have been found in various parts of the county will readily suggest the location of their villages and workshops.

Douglassville, settled by the Swedes and called by them Molatton, is known to have been an Indian rendezvous, but owing possibly to the land along the Schuylkill lying low, and consequently often flooded, the "flint chips" which would mark the position of the wigwams, have no doubt been covered up by sand and river detritus.

Neversink Station, in Exeter township, further up the Schuylkill, must also have marked the position of a considerable Indian village.

Mrs. DeTurk's farm, a little N. E. of the railroad station, is well watered by several excellent springs, the natural location of the aborigine, and the proximity of the large boulders of Mesozoic conglomerate piled upon one another, furnished, with the aid of skins and bark, a good natural shelter. But more important still, in addition to the great variety of implements which have been found here, many fragments and "chips" are scattered over the surface, indicative of former activity.

Jonas D. DeTurk's farm, upon which Neversink Station is situated, was also the seat of an Indian village, and his fields along the river are full of chips and relics. Mr. Brunner, with three companions, picked up over a hundred specimens here, including a fine axe, in 1879, a majority of which were perfect.

There is but little doubt that this village extended up the east bank of the Schuylkill as far as the Big dam, as the intermediate farms have all supplied many additions to the specimens already noted.

On *Mr. Christian's farm* the relics are especially abundant, and singularly enough the chippings are largely composed of jasper and chalcedony, which, being foreign to the locality, indicate the importance of the village and workshops in this locality.

Dick's Island, opposite Neversink Station, exhibits rough fragments of quartzite, jasper, and chalcedony, brought there by the Indians to be hewn into their various implements, as well as many perfect articles besides.

Dick's & Lewis' farms, on the west bank of the river opposite Dick's Island, are remarkable, the former as being one of the renowned localities for relics, and the latter, belonging to Mr. Wm. Lewis, as having furnished many rare specimens.

Even more prolific than these have been are the *Poplar Neck farms* of Ezra High, from which many large specimens have been taken.

Mr. High is an enthusiast on the subject, and among the 800 and over specimens in his collection he exhibits the largest axe found in the county, weighing 9 pounds.

Fritz Island and the farm now owned by the Reading Land Improvement Company have furnished their quota of remains that denote an Indian settlement, while further north, the city of *Reading* bears evidences of having been an Indian town of considerable size.

At the foot of Sixth street, where Harbster's foundry stands; Tenth and Spruce, and in the direction of the Mineral Springs, arrow heads and "chips" have been found in quantities. The proximity of the Potsdam quartzite hills here furnished abundant material for the application of Indian art; in addition, its secluded position and well-watered territory all suggest Reading as likely to have been a favorite abode.

Tulpehocken, to the west of Reading, was one of the most widely known settlements, and the first to be mentioned in history.

The village was located a little east of Stouchsburg, principally upon land now owned by Mr. Bubp and William Rieth; but though the profusion of remains suggests this as the site of the village, relics have been found all along the banks of the Tulpehocken to its mouth on the Schuylkill.

Bern must be noted as a probable sojourning place of the

Indian, especially east of Leinbach's hotel, as a variety of implements have been found there.

Leesport, and the surrounding farms, especially those belonging to the Iron Co. & Messrs. A. H. and John Gernant, were occupied by large numbers of Indians. But few relics are found further north than this.

Moselem, on the Ontelaunee, or Maiden Creek, is abundantly supplied with implements of Indian workmanship, though the whole course of this stream has been marked to a less degree. A considerable distance up Moselem Creek, which the Indians called *Maschilamehanne*, or *Trout Stream*, there are evidences of a dense Indian population.

Virginsville, at the confluence of the Sacony and Maiden Creek, was one of the most extensive towns in the county. It was called *Sacunk* by the Indians, signifying *Place*, or *Outlet of a stream.*

The farms upon which the relics are most numerous here are those of Messrs Chas. Adams, Jacob Leiby, Augustus Lenhart, Simon Dreibelbies, Abraham Fink and Ephraim Dreibelbies.

The table on the following page is taken from Mr. Brunner's book on the Indians of Berks county, page 76, and is entitled "Collections of Indian Relics."

The preceding table is not intended to be a complete classification of all the relics found in Berks county, for many of them have been carried out of the county, and found their way into private collections; but rather as an *index* of the principal collectors and an *approximation* to the number of remains that the county has yielded.

Indian Implements.

Totally bereft of the mechanical appliances of to-day the Indian implements were necessarily very rude. Their axes, knives, spades, spear-heads, arrow-heads, jewelry, beads, etc., were all made of stone, but in the selection of suitable material proves their primary knowledge of Lithology.

When the Indian habits were first studied, they already showed great adaptability in using the articles they obtained as presents and payments from the white people, so

Collections of Indian Relics.

Names of Collectors.	Ornaments.	Pestles.	Celts.	Axes.	Hammers.	Spear heads.	Arrow heads and other chipped implements.	Total.
Chas. A. Klink, Douglassville, .	2	. .	1	5	. . .	. .	500	508
Jonas D. DeTurk, Neversink Station, ...	4	7	5	10	12	. .	400	438
Isaac D. DeTurk, Neversink Station, ...	6	4	5	11	6	. .	2,480	2,512
A.J.DeTurk, Neversink Station,	. .	. .	3	3	3	. .	160	169
Solomon H. Christian, Neversink Station, ...	3	1	2	4	. . .	. .	320	330
Henry D. Dick, Neversink Station, ...	. .	. .	2	2	2	. .	125	131
Amos Lewis, Big Dam, ...	8	3	1	5	6	. .	475	498
Ezra High, Poplar Neck, . . .	5	4	8	20	10	15	800	862
Cyrus R. Yost, above Poplar Neck, ...	1	1	. .	. . .	3	.	350	355
Charles W. Berg, Cumru, . . .	6	2	3	13	8	12	1,410	1,454
S. L. Young, Reading, ...	1	5	4	40	. . .	16	200	266
Henry Weidensaul, Reading, .	. .	. .	3	4	3	. .	150	160
I. W. Keim, Reading, ...	2	2	. .	2	2	. .	100	108
D. B. Brunner, Reading, . .	6	20	. .	52	58	21	4,350	4,507
Society Natural Science, Rdg.,	. .	. .	2	10	. . .	. .	200	212
J. H. Buph, Stouchsburg, . .	. .	10	. .	20	48	. .	1,000	1,078
William Rieth, Stouchsburg, .	. .	7	. .	20	13	. .	170	210
Franklin B. Rieth, Stouchsburg,	. .	8	. .	2	18	. .	300	328
H. L. Illig, Millbach, .	1	.	. .	12	. . .	. .	500	513
H. J. Herbein, Sinking Springs,	. .	1	. .	3	6	. .	40	50
Abraham H. DeTurk, Leesport,	. .	1	. .	4	. . .	. .	1,200	1,205
W. J. Dreibelbies, Virginsville,	. .	. .	. .	1	5	. .	50	56
Alf. S. Dreibelbies, Virginsville,	. .	. .	. .	6	3	. .	50	59
Abrm. G. Mengle, Virginsville,	1	. .	1	. . .	. . .	1	100	103
Jonas J. Boyer, Virginsville, .	2	. .	. .	1	. . .	. .	13	16
L. H. Lesher, Perry, ...	. .	3	. .	4	. .	. .	53	60
Dr. C. Wanner, Kutztown, . .	. .	1	. .	8	1	. .	105	125
E. J. Sharadin, ...	. .	4	. .	. . .	4	15	950	973
Samuel C. Bast,* Kutztown, . .	. .	. .	. .	13	. . .	. .	500	513
Wm. K. Deisher, Maxatawny, .	. .	. .	1	2	2	. .	120	125
Walker S. Fritz, Wernersville, .	. .	.	. .	1	1	. .	24	26
A. F. Berlin, Allentown, . . .	. .	5	. .	20	. . .	. .	1,000	1,025
	48	89	41	298	214	80	18,195	18,965

* Estimated.

that it is impossible at the present day to state what were the exact uses of some of the various implements. A partial description of these is however appended. The cuts, illustrative of these implements, are all taken from Mr. Brunner's book.*

Axes. The axes were generally made of some hard rock such as trap, syenite, and compact sandstone or quartzite.

Loskiel describes them as "wedges of hard stone, six or eight inches long, sharpened at the edge and fastened to a wooden handle. They were not used to fell trees, but only to peel them or kill their enemies." There are two kinds of axes—the *grooved* and the *ungrooved.* Of the first class Fig. 1. is a good illustration and is a reproduction of the axe found on Monocacy Hill by Mr. F. S. Updegrove.

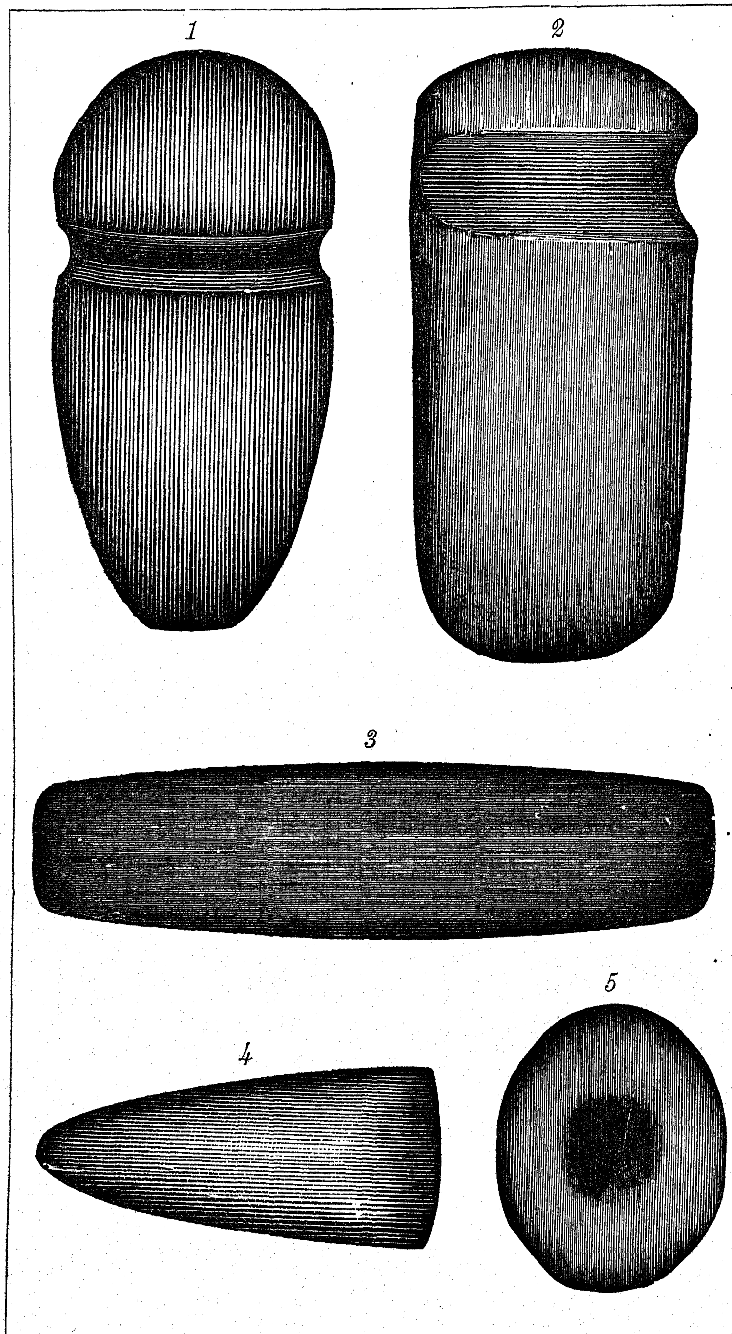
It is 6 inches long and 3 inches wide; the cut is about ¼ natural size. The cutting edge of the knife is scarcely an inch in length, and has never been subjected to rough usage. Fig. 2 is an excellent specimen of a great number of axes found in Berks county, some of which slope more towards the cutting end, while others have large polls and with few exceptions, are grooved all around; this one is grooved only on 3 sides. It was found near Fritztown by Dr. Schoenfeld, of Reading.

Pestles.—The pestles form a numerous class of relics, and vary in length from 4¼ inches to 23 inches. The majority of them were used for pounding and grinding corn, but from the variety of forms found, they appear to be adapted to a variety of uses.

They have been found in Maxatawny, at Neversink Station, Union township, Bern, and elsewhere with the general form of Fig. 3 (half natural size) which represents ¾ of those found. Some are cylindrical and differ only in length and diameter. This one is regularly shaped and well polished.

Celts.—The *celts* or chisels bear some resemblance to axes, and vary in length from 4 to 7½ inches. It is a cutting tool,

*The cuts reproduced in this sketch are such as will illustrate the largest class of specimens found, rather than any special or unique article, and are, as far as may be, types of the more common forms found in the county.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but was never used in working or modelling hard material, if we are to judge from the smooth and unbroken appearance of the corners and edges of the specimens found. They were possibly used for dressing skins or some equally soft substances.

Fig. 4 shows the more common form of this instrument. It is composed of diorite, and was found on Mr. A. D. Dick's farm on the Schuylkill below Reading. The cut is half natural size.

Hammers.—This class of implements form a large proportion of the relics found in the county, and those found show every conceivable shape and form according to the fancy of the artisan or the character of his material.

Probably the most common class of hammers is shown in Fig. 5, half natural size, used mostly to crush corn, for which purpose they were made of pebbles, with cavities in each side for the insertion of the fingers to hold them firmly.

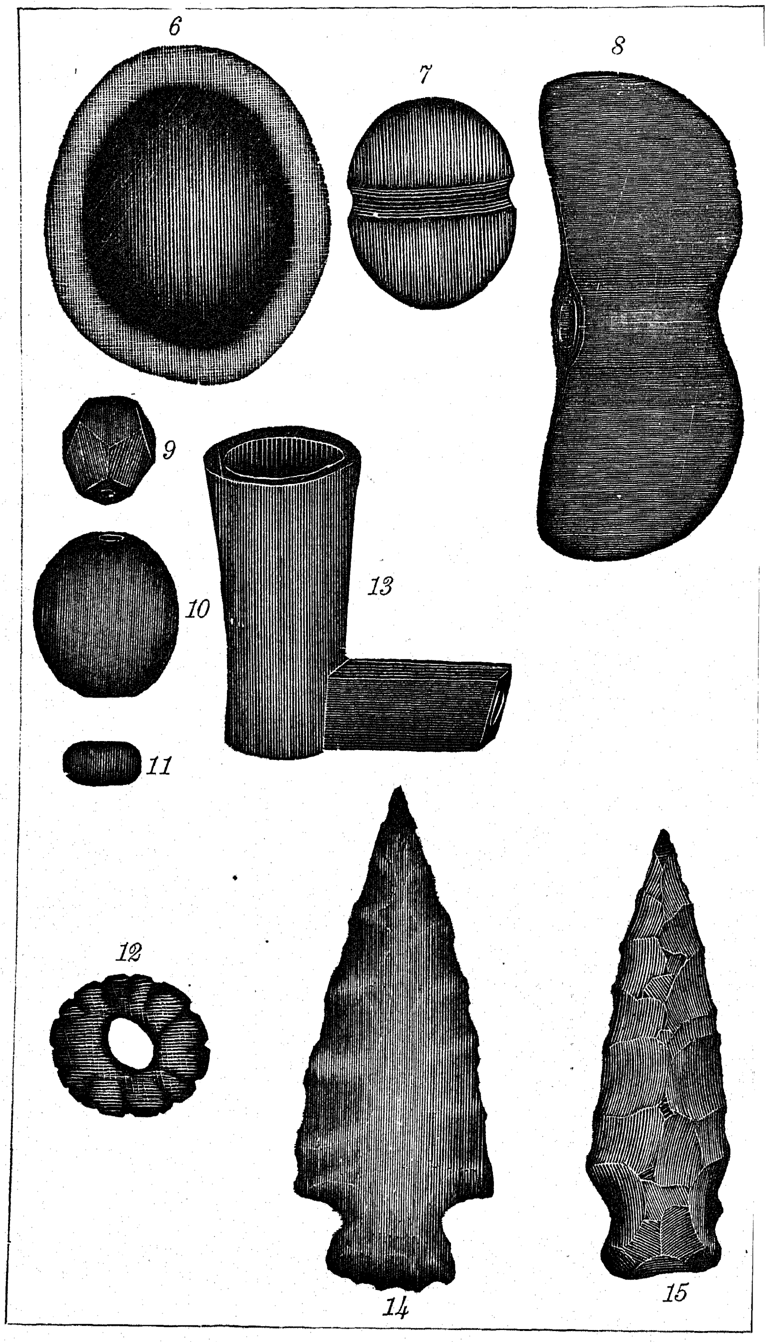
Great numbers of this class of hammers have been found on the farms of Ephraim Dreibelbies and Simon Dreibelbies, Virginsville, though the special one figured is from T. B. Knabb's farm in Oley. It is considerably worn on the edges.

Millstones.—A few of the smaller Indian millstones have been preserved, the larger specimens having been used for fence building, etc. They formed the hearth upon which the corn was ground by means of the pestle, and usually show shallow cavities on one side for receiving the corn. A nearly similar class of relics are the

Mortars, which differ in being smaller and having deeper cavities, supposed to be used in the preparation of pigment for coloring their faces.

Fig. 6 is the natural size of the most common form, found at the base of Monocacy hill. The outside is highly polished, dark brown, and the inside smooth, with a light yellow color.

Sinkers and Pendants are names generally applied to instruments intended for suspension, either for attachment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to fishing lines or in the case of the larger varieties, for use in weighting fish nets.

Fig. 7, half natural size, is a common form of these relics, made usually of hard and compact rock with a groove entirely around them, and generally well polished.

Ceremonial Weapons.—A name applied to articles of still unsettled use. They are made of all kinds of stone, jasper excepted, but commonly of the softer varieties such as slate and serpentine limestone. The majority of them have a large hole drilled through the middle of them laterally, which would materially impair their strength. Most of them show perfect edges also, so that they could not have been well used for violent work.

Fig. 8 is a very fine specimen from William Lewis' farm. It is made of diorite and highly polished; 3¾ inches long and ¼ inch thick in the middle, tapering towards both ends.

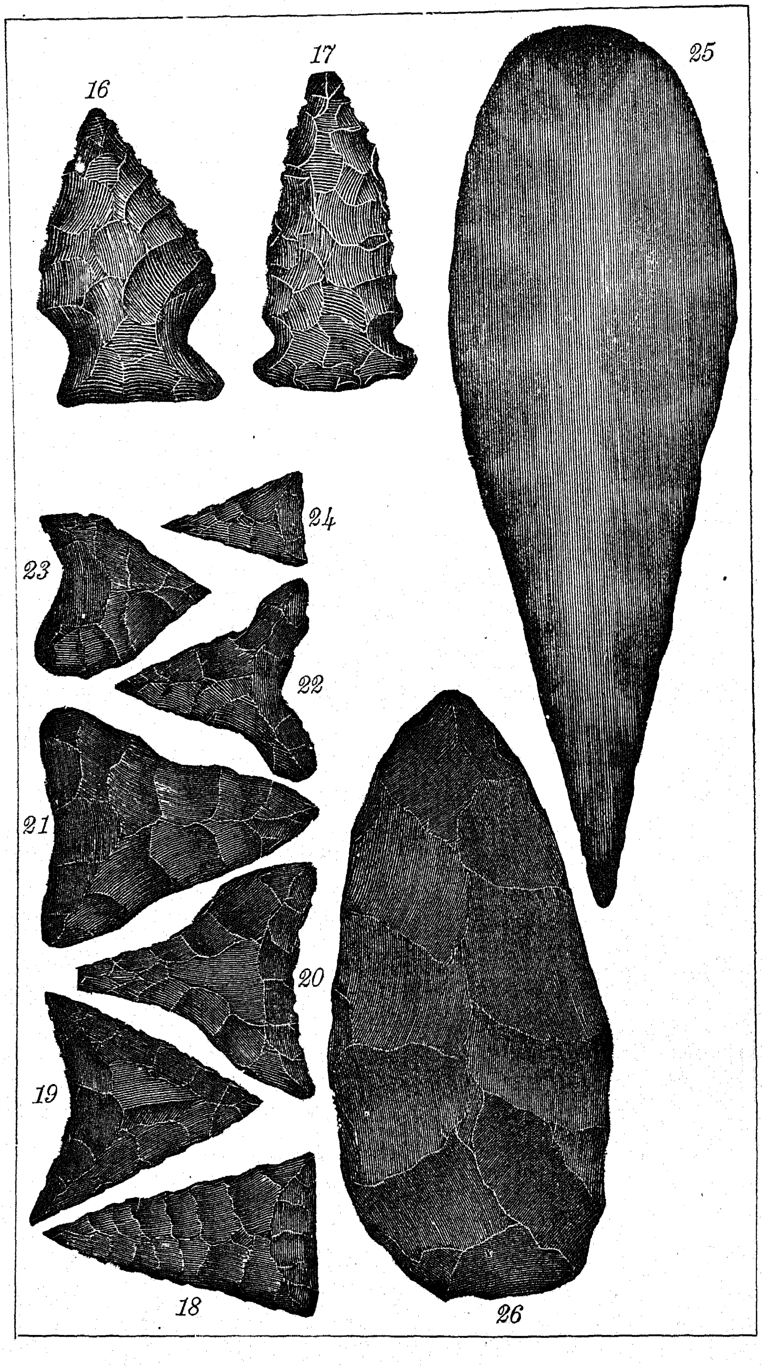
Beads and Shells.—A few of these have been found in the county, especially in the vicinity of the old Indian graves, and four varieties are presented in Figs. 9, 10, 11, and 12, natural size.

The first three are from a string of sixteen beads in Mr. E. J. Sharadin's collection, of which five are similar to Fig. 9, with eight pentagonal faces. The ten largest (Fig. 10) are of enamel, the others, of which Fig. 11 is the smallest, are of glass. Fig. 12 is of soapstone and notched at the circumference.

Pipes.—Many of the pipes were probably made of perishable material, owing to the scarcity of these relics in comparison to those of other classes. Fig. 13 is a cut of a very beautiful and perfect specimen, now in possession of Mr. Henry M. Keim of Reading, and supposed to have been found in the vicinity of Pricetown. It is made of dark serpentine tinged with red.

The hole in the body of the pipe is regular and corresponds with the outside in its form. This pipe is exceedingly well preserved with the exception of the stem which was probably longer.

Arrow Heads constitute by far the largest class of relics, and whether from the variety of their form or different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rock material, they occur profusely around the sites of the old Indian villages, where they were manufactured in great quantities. They are made of hard rock usually, quartzite, flint, and jasper chiefly.

Fig. 14 is a sample of the largest arrow heads, made of quartzite, and representative of a large class.

Fig. 15 is also of quartzite, but belongs to a more slender class of relics, which were generally supposed to be attached to sticks.

Figs. 16 and 17, the former notched at the sides with a straight base, the latter the same with a convex base, are the medium size specimens, which represent a large class in the county.

Triangular Arrow Heads form another class of great variety in proportion to their number.

Figs. 18 and 24, with straight sides and bases, are most commonly met with.

Fig. 18 is in Mr. Ezra High's collection; is made of jasper and chipped most beautifully.

Fig. 19, straight sides and concave base, is a common form of the triangular arrow head.

Fig. 20, a specimen belonging to Dr. C. Wanner, is rather unsymmetrical, with a blunt end, and could not be used for an arrow head.

The peculiarity of No. 21 is the round corners, and is not very frequently found.

Fig. 22, concave sides and base, is also rather rarely found.

Fig. 23 is most too irregular for use as an arrow head.

Knives.—The Indians are supposed to have had two kinds of knives, a smaller class that were attached to handles and a larger class that were sufficiently long to be used without special handles.

To this latter class Fig. 25 (natural size) belongs.

It is made of quartzite, and is so classed, not so much on account of the fine cutting edge as its fine point.

Fig. 26 represents the most common form, found abundantly all over the country, and generally made of quartzite and jasper.

In addition to these figures there is a large number of relics of unknown uses, many of them of unique shapes, figured in Mr. Brunner's book; but they do not essentially represent any large class, and are not consequently reproduced in this short sketch of the more common varieties.

The subject is an interesting one, and among the many fine collections in different cabinets of Berks county there should be sufficient material for a more complete and detailed report.

Index of Names, to D^3, Vol. II, Part I.

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Other Reports of the Survey are in the hands of the printer, and will be published soon.

The sale of the reports is conducted in accordance with the provisions of Section 10 of the Act of the 14th day of May, 1874, which directs that copies of the Reports, with all maps and supplements, shall be furnished *at cost of publication to all applicants for them.*

All the printed volumes and maps in stock have been transferred by the Board of Commissioners to the Department of Internal Affairs, where the sales thereof will hereafter be conducted.

Communications relating to the work of the survey should be addressed to J. Peter Lesley, State Geologist, No. 1008 Clinton street, Philadelphia, and those intended for the Board of Commissioners, to William A. Ingham, Secretary, No. 320 Walnut street, Philadelphia.

All letters and orders concerning the purchase of Reports and remittances for the same, should be address to,

J. SIMPSON AFRICA,
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Harrisburg, Pa.

October 4, 1888.

Date Due
